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MACHINERY:

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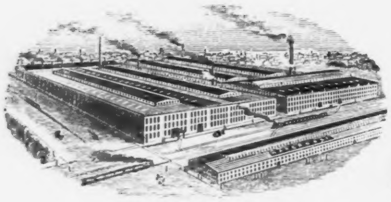

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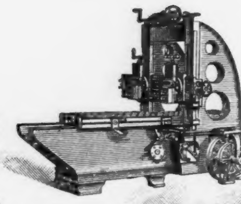

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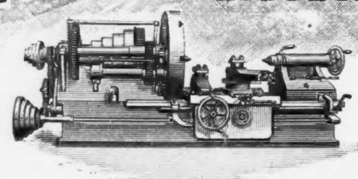

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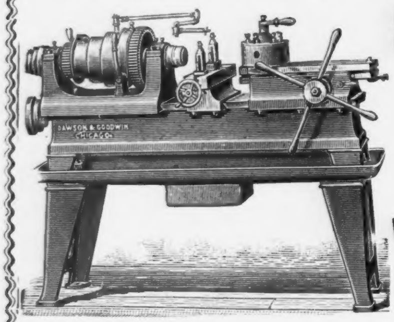

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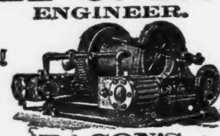

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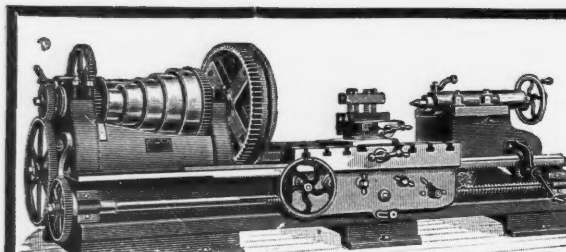

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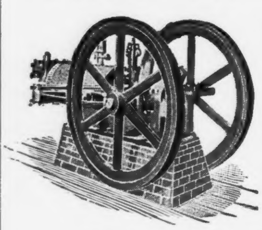

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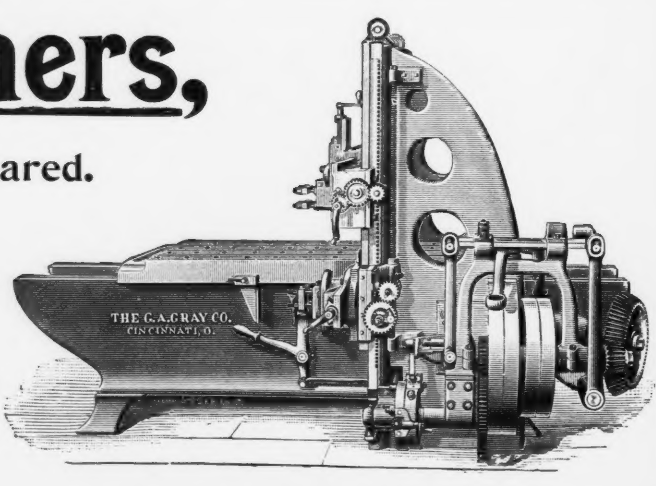

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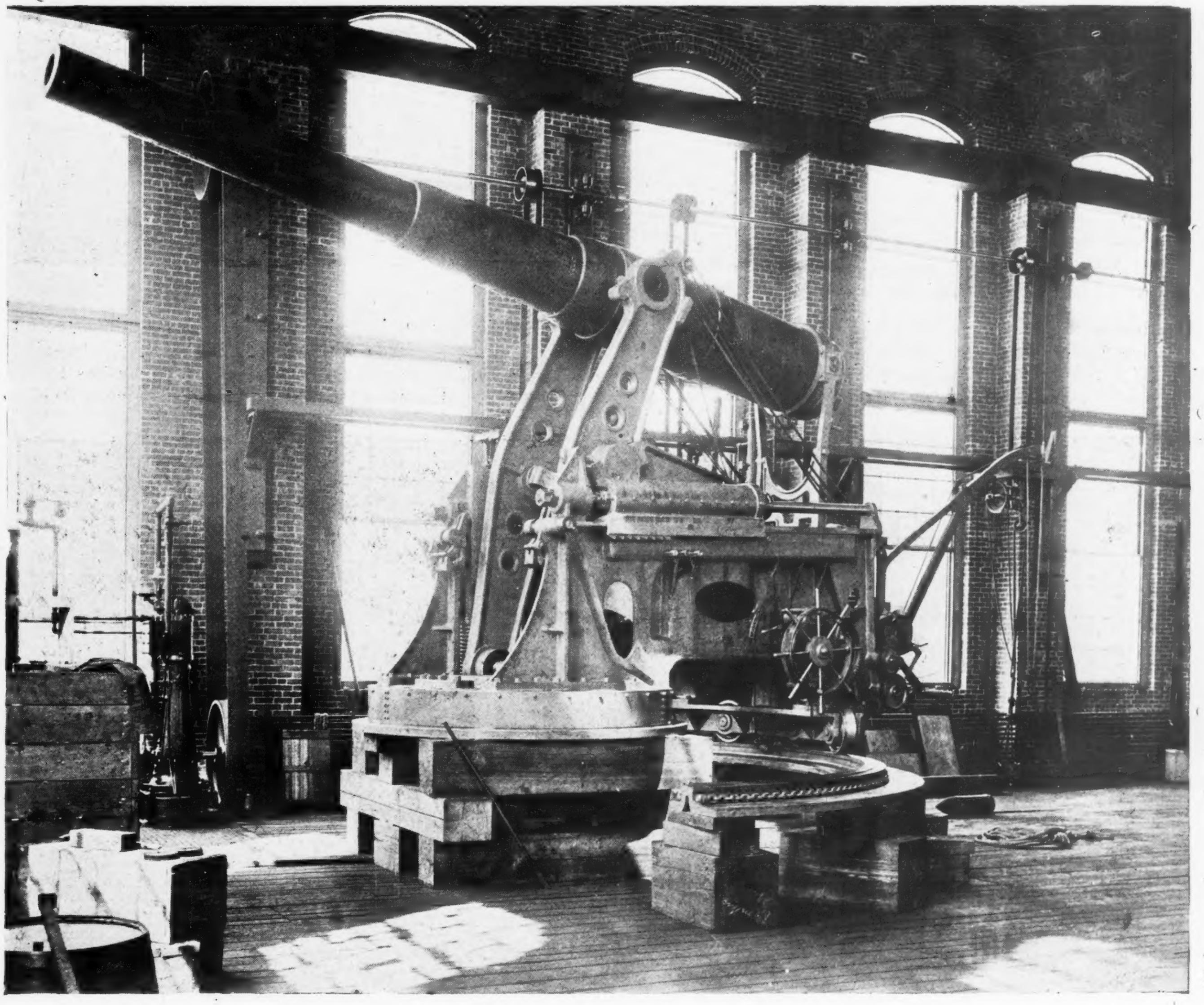
MACHINERY.

VOL. 3. October, 1896. No. 2

WATERTOWN ARSENAL.—2.

ALMOST everything in the line of machinery products has its origin in the pattern shop, and this is a very well-lighted and pleasant place to visit. It will be noticed that there are two rows of windows, one above the other, which is unusual for a one story shop. but it gives good light, which is essential to the best of work. This is pretty thoroughly equipped with tools, from the well-known pattern shop standby, the Daniel's planer, to improve boring machines, buzz planer, band saws, etc , etc. An idea of the heavy patterns made here can be obtained from the weight of the gun carriage castings, being in some cases 15 tons for each side of the carriage. The use of mortising machines in pattern shops generally is not as universal as their usefulness and money-saving qualities warrant.



TEN INCH GUN IN BUFFINGTON-CROZIER DISAPPEARING CARRIAGE.

BLACKSMITH SHOP.

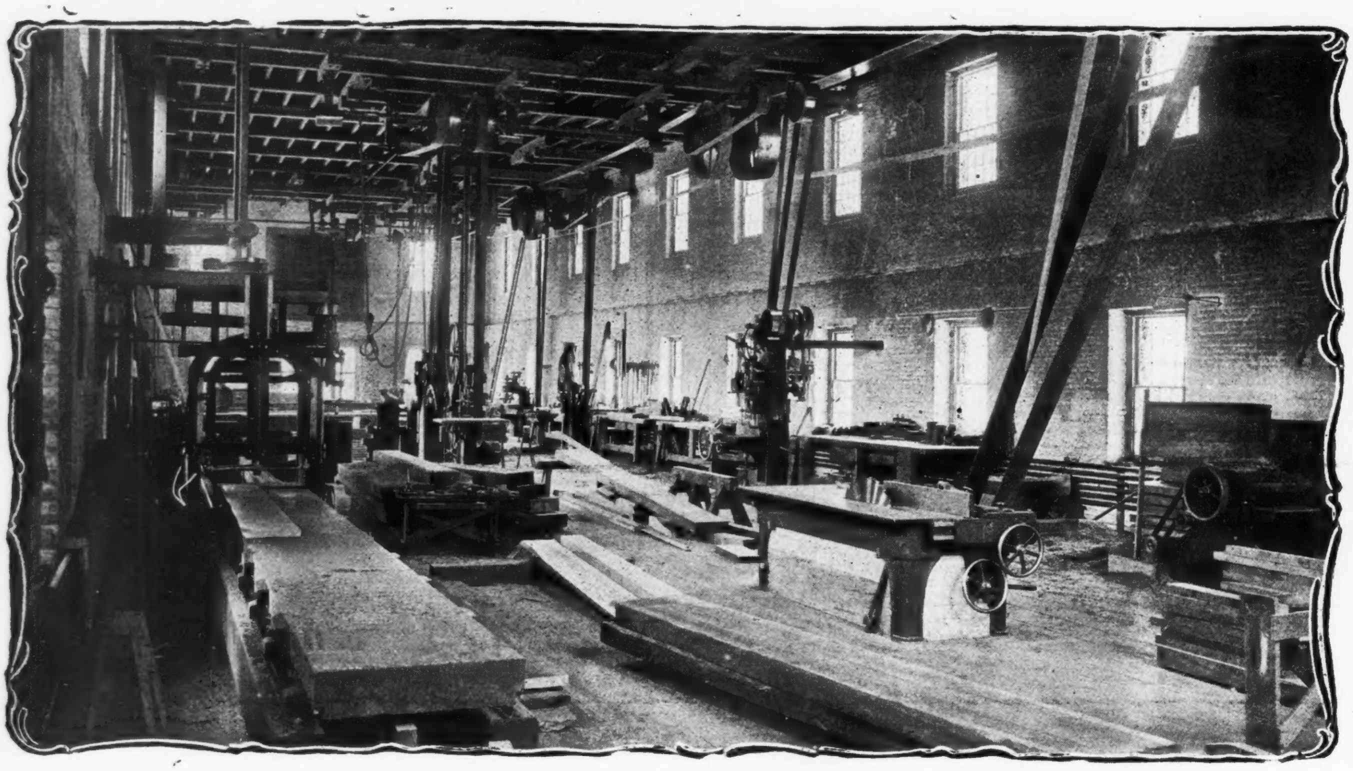
Another source of machine building is the blacksmith shop, the general view of which was shown in the group in last month's paper. The interior is illustrated on the following page.

This is a building 46 x 300 feet and is quite well equipped for this branch of the work. The main view is taken from the end of the shop occupied by the small forges, away from the power hammers. This end is supplied with swinging jib cranes, heavy enough for this class of work.

The view of the steam hammer shown on the same page gives a good idea of its size and shows how it is served by a large swing crane, made by Wm. Sellers & Co , of Philadelphia. The piece shown was red hot on the end while the view was being taken, and, as the camera was within a few feet of the furnace, the temperature was decidedly warm, to put it mildly. This hammer is said to weigh about 100 tons and to strike a blow of 125 tons. Its steam cylinder is 22 inches in diameter with a stroke of about 4 feet, the piston rod being 6 inches in diameter. The hammer head weighs 6 000 pounds, the die 2 500, and when forced by 90 pounds of steam behind the piston, the blow that can be struck is something tremendous. The hammer will admit a piece four feet high by ten feet wide. This is the kind of a hammer which is so delicately adjusted that a watch crystal can be cracked, etc., etc., but like the boil Josh Billings told about, it is better to let someone else try it, or else borrow your wife's watch. The scrap iron, odds and ends, etc., are worked up into billets and then drawn out into bolt iron or for similar work.

ERECTING SHOP.

The erecting shop, at the rear of the machine shops, is a commodious building, 80 x 280 feet, and splendidly lighted, as will be seen from the small view on page 41. When this is completed it



THE PATTERN SHOP, WATERTOWN ARSENAL.

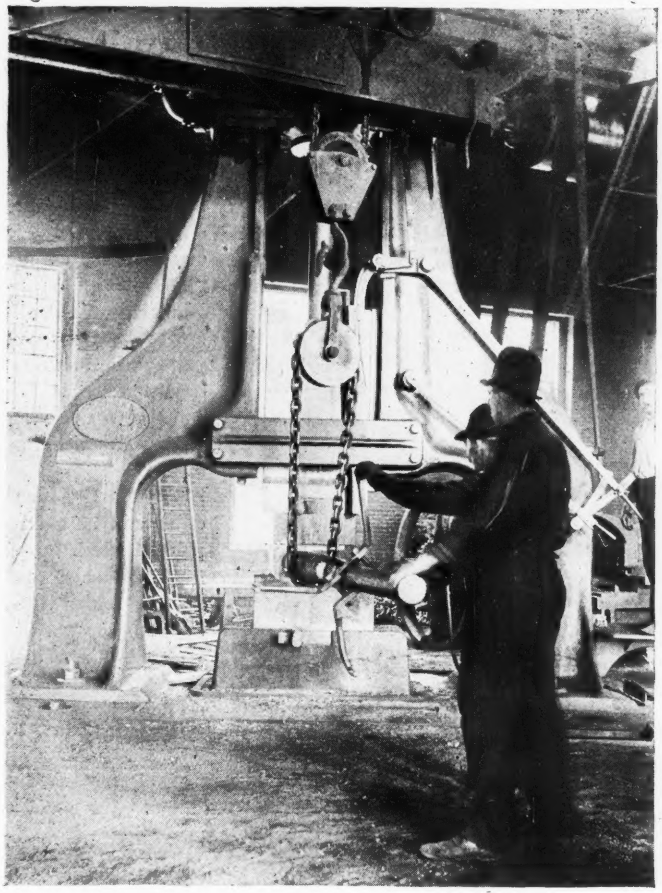
will be one of the finest shops of the kind we know of. It contains two 25 ton cranes built by the Shaw Mfg. Co., of Muskegon, Wis., which will eventually be operated by electricity, but are for the present manipulated by hand. As intimated in the opening

THE BLACKSMITH SHOP, WATERTOWN ARSENAL.

of the last article, this plant is by no means as complete as Major Reilly would like to have it, and as soon as sufficient appropriations are made, a complete electric system will be installed for lighting and power where ever deemed advisable. Among the interesting features here are the weighing scales, which are fastened to the crane hook and which weigh and record the weight while the piece is being loaded or unloaded. Their capacity is 20 000 pounds.

Some of the gun carriages here are of the hydraulic disappearing type, where the whole carriage, gun and all drop out of sight of the enemy. This is, of course, nothing more nor less than a huge hydraulic elevator, where the load handled is upwards of 50 tons. The popular gun carriage is, however, the Buffington-Crozier type, a model of which was illustrated last month. The small view shows one side of the shop with its stock of carriages of different types and sizes, and the large counterweights in the

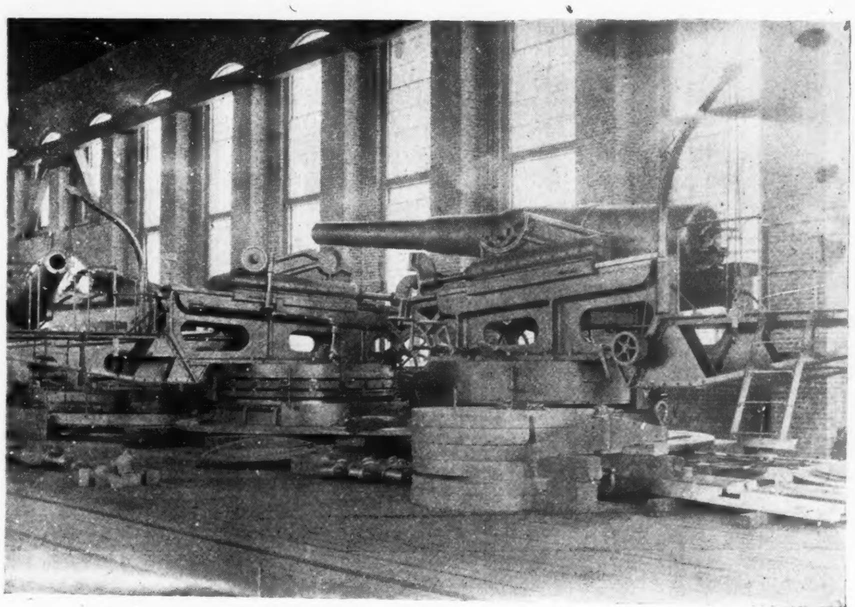
foreground. As the genuine article itself is always more interesting than a model, the ten-inch gun and its carriage, in firing position, will be of interest to all. It also shows, somewhat to the detriment of the picture, the excellent lighting of the shop by



LARGE STEAM HAMMER, WATERTOWN ARSENAL.

the tall windows, as well as the runway for the cranes, supported on the brick piers built out from the wall. The gun alone weighs about 67 000 pounds, which gives an idea of the work of raising it, as well as of the recoil. The connecting rods are made of steel and as light as is considered safe, in order that they may spring rather than break.

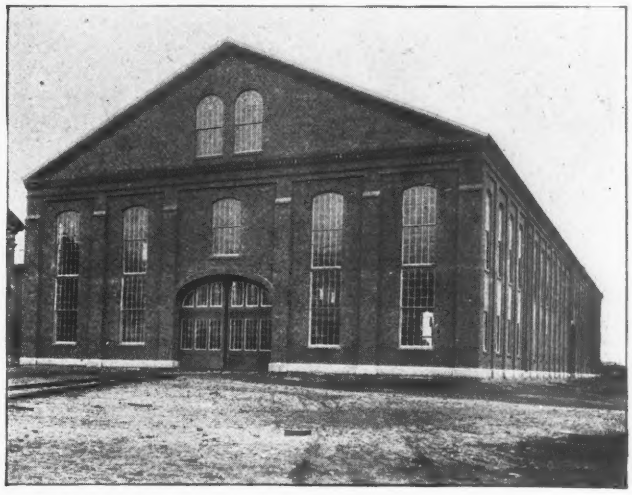
The government has here a testing machine which is said



IN THE ERECTING SHOP, WATERTOWN ARSENAL.

to be unequalled by any other, in combining great strength with unexampled accuracy and the range of specimens which may be tested. The price paid for it, $31,500, is not nearly its real value for the purpose for which it is intended, or, as stated later, the actual cost of its construction. This is the original machine of this type and was made by the Ames Manufacturing Co., Chicopee, Mass., under the direction of the inventor, Mr. A. H. Emery, C. E. These machines are now built exclusively by Wm. Sellers & Co., of Philadelphia, in various sizes.

The machine, which has been described before, is without doubt, the most ingenious and probably the most correct testing machine made—its cost preventing it being more widely used. It has no knife edges to either wear or cause friction, and is about as near frictionless as it seems possible to make any machine; the whole pressure being taken on liquids and transferred to beams,



ERECTING SHOP, WATERTOWN ARSENAL.

which are very neatly supported without knife edges. The hydraulic support for taking up the shock of recoil is such that these machines can be used regularly for breaking high grade steel specimens up to the full capacity of the machines, without risk of injury. The arrangement for weighting the beam as desired, without touching the hands to the weights or opening the glass case, is both ingenious and valuable, and the indicator needle, multiplying the movement of the testing head from 300 000 to 6 000 000 times, according to the size of machine, makes the readings exceedingly accurate.

The following extract from their report shows what the Examing Board thought of the machine:

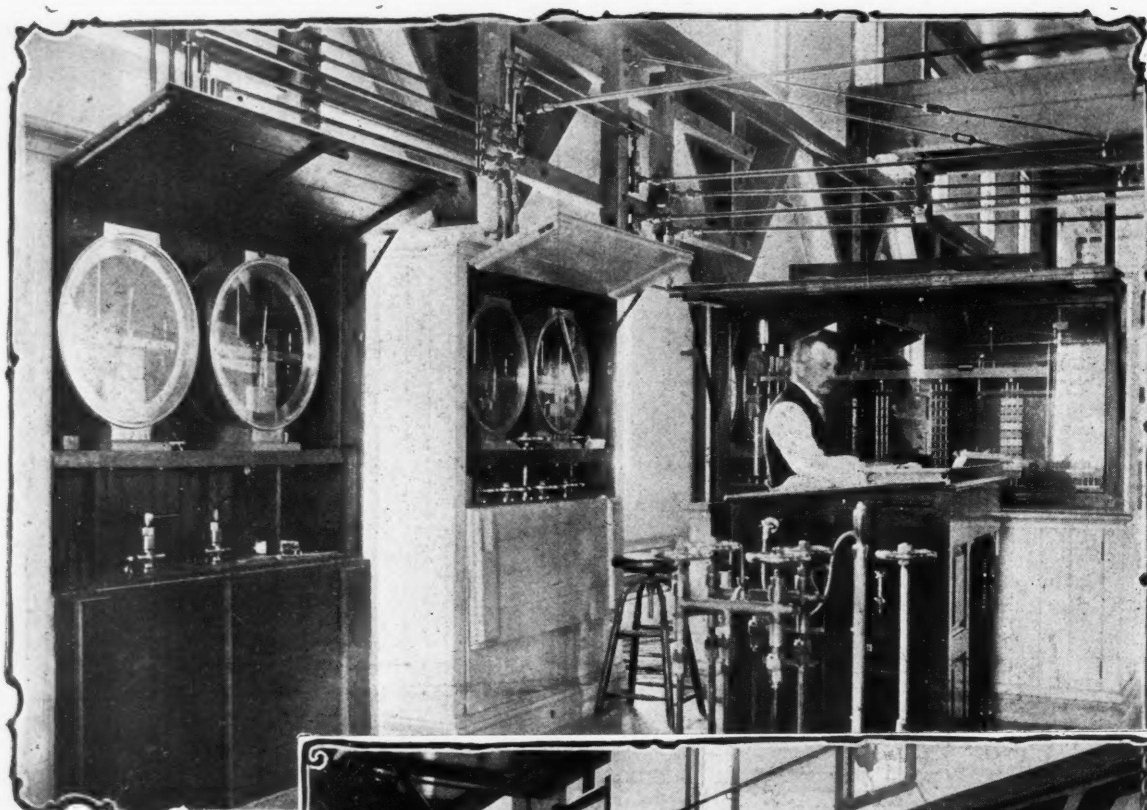
"The Board, having subjected the testing machine, submitted by Mr. A. H. Emery for their approval, to the maximum strains contemplated by the terms of the contract, viz., a strain of compression of 1 000 000 pounds, and the rupture of a hammered wrought iron bar 5 inches in diameter by tension, with no injury to the machine, accepted it. The highest expectations of the most sanguine members of the Board have been fully realized in this machine. As was expected, it surpasses all others used for this purpose in combining in itself wonderful accuracy and delicacy with great strength. Immediately after the rupture of the 5-inch bar, in order to prove that the machine had sustained no injury by the shock, it was used to determine the strain required to break a horsehair, and the result agreed with that given by a small spring-balance used for the purpose. Page 42 shows the testing machine as seen from one corner of the room in which it is placed. It consists of a heavy cast iron head, bolted securely to a strong stone foundation 10 feet deep. Two 8½-inch screws 48 feet long connect this head with the double-acting straining cylinder, mounted on a truck, and moved by steam power to any desired position required by the length of specimen to be tested, and held in place by four bronze nuts on the large screws. The straining cylinder is connected by pressure pipes having elbow joints to the cylinder of the accumulator, so that a steady strain, without the pulsation of the pump is brought upon the specimen in testing.

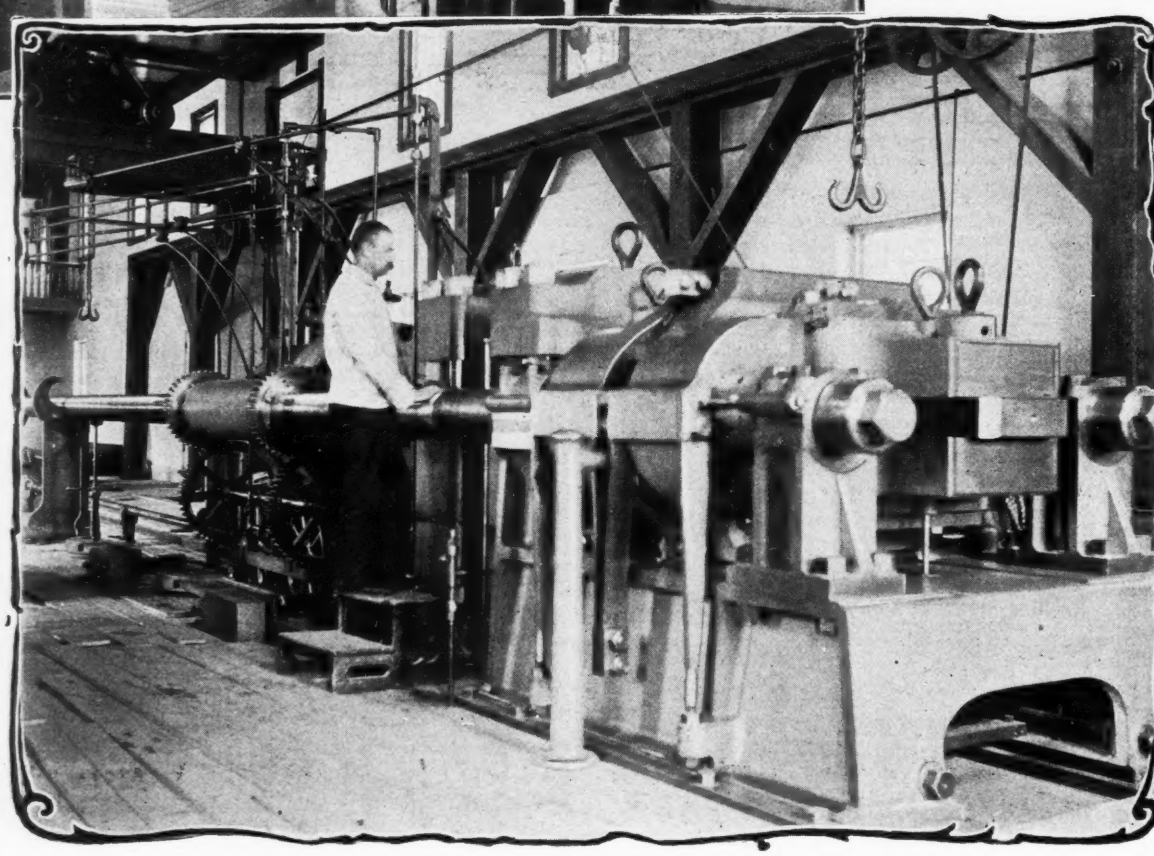
"The strain on the specimen is brought to bear directly on a hy-

drostatic press in which the pistons are replaced by diaphragms, and very small pipes, filled with alcohol and glycerine, connect this with another smaller one placed at a convenient distance from the machine and operates a series of levers, and finally the scale-beam, which is kept balanced by the application or removal of weights, effected in a manner in the highest degree ingenious and expeditious. Before there can be any movement of the indicator of the scale-beam, there must be a motion in pieces of the head, weighing in the aggregate 24 000 pounds; but so delicately is it balanced, and so slight is the extent of the motion, that a pressure of one pound is sufficient to communicate a visible motion to the indicator. The holders which embrace the specimen to be tested are arranged to hold, besides the ordinary shapes, round and flat bars, and also plates up to 30 inches in width. The length of the specimen may vary from one inch to 30 feet.

"A distinguishing feature of the machine is the absence of all knife edges for fulcra of the levers. They are replaced by thin sheets of steel, thus avoiding the friction of these surfaces. The machine has been finished in all its parts in the most accurate, careful and painstaking manner. Nothing has been omitted which would add to its permanent value. So particular has the inventor and instructor been in applying to this machine all the improvements which were suggested during the progress of the work, and in making it as perfect in all of its details as possible, that he expended in its construction a much greater sum than he received for it. With the drawings already made, and the patterns and gauges prepared, it would not be possible to duplicate the machine for the sum he has received. It always happens in the development of a new idea, as in the present instance, that obstacles are met with which no human foresight could predict; these had to be contended with and means devised to overcome them; they have been met most successfully, but at great expense of time, labor and money on the part of the contractor. The machine is more perfect than we had any right to expect from the terms of the contract. The Board is of the opinion that the government should, under the circumstances, come to the relief of Mr. Emery, and not allow him to suffer so severely for his unusual devotion to its interests. Justice and equity alike demand it."

The Watertown machine can be used for private tests by paying the cost of operation, which is usually about $3.00 per hour, and it is strange that more builders do not avail themselves of this opportunity. At the time of the writer's visit tests of various forms of riveted boiler seams were being made for the Hartford Boiler Insurance and Inspection Co., of Hartford, Conn.





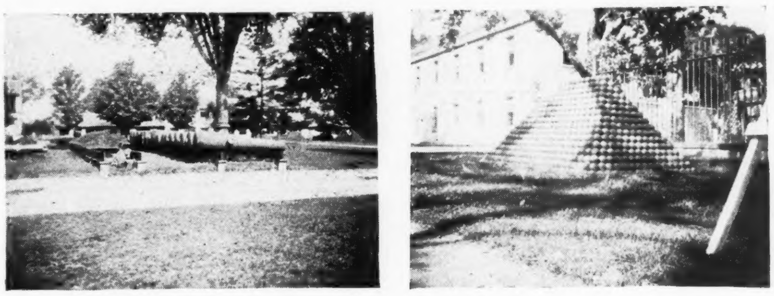
TESTING ROOM, WATERTOWN ARSENAL.

The upper view on this page shows the new indicating and recording instruments which have recently been put into place for this testing machine. The gentleman at the desk is Mr. J. C. Howard, C. E., who has charge of this very interesting department, and who at the time was engaged on the test of boiler seams above referred to.

A POSITIVE REDUCING MECHANISM.

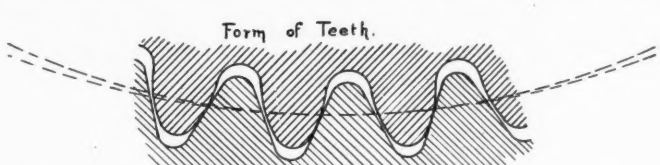
H. K. Landis, E. M.

While inspecting the admirable power equipment of the Columbia Tube Works, at Hartford, Conn., some time ago, I was much interested in a device, the application of which as a speed reducer was new to me, and in which I saw some possibility of similar application. Differential devices are common just as speed reducers are common; but endless screws, cone pulleys and gear trains are not so popular but that another device may



RELICS OF THE WARFARE OF THE PAST, WATERTOWN ARSENAL.

find a place somewhere between the foundry or forge and the assembling floor. Incased entirely in a cast iron cover 18 inches diameter and 32 inches long, it converted the 45 revolutions per minute to $\frac{1}{80}$ revolutions of a shaft driving a Coxe traveling grate without perceptible noise or vibration, and with ease. The worm wheel and endless screws formerly used required too much care, and repairs and have been therefore discarded. Briefly, it consists of a four-step cone pulley connected with the line shaft driving the boiler blast fan. This pulley is keyed on a sleeve on the other end of which is the eccentric inside of a geared pinion having 44 teeth; this pinion engages with two inside gears, one on the fixed outside casing having 50 teeth, and the other with 51 teeth on a sleeve carrying a second eccentric; the pinion revolving on this second eccentric has 64 teeth, which gear into another inside or annular gear wheel of half its width with 70 teeth, and another similar gear having 71 teeth keyed to the driving shaft. The length of the pinion tooth is more than twice that of the inside gears, and serves to keep them in line. This alignment necessitates the regression of the wheel having one tooth more, so that when, under the action of the eccentric the pinion travels once around the central shaft, the loose inner gear has been forced back one tooth. Therefore in 51 revolutions of the pulley the second eccentric revolves once; similarly in 71 revolutions of the second eccentric the shaft revolves once; or this shaft makes one revolution for every 3621 revolutions of the pulley. In the case cited, the pulley made 45 revolutions per minute, causing the traveling grate to have a steady uniform motion, scarcely perceptible, of 3 to 6 feet an hour, as desired. The form of gear teeth are specially designed to resist wear, their size depending upon the work to be done, and their number upon the extent of speed reduction required. A quantity of oil is kept



in the bottom of the casing, insuring good lubrication. The advantages of such a reducer are: (1) it is positive; (2) it is uniform and steady; (3) the reduction can be carried to any extent desired by increasing either length or diameter of the mechanism; (4) as the normal pressure on the teeth is small and lubrication good, repairs are found to be very low. This device is not new, but its excellence is such that it deserves a wider application, and it is for this reason that I bring it before the notice of the readers of this paper.

The power plant mentioned is interesting because it embodies many of the modern ideas in boiler-house economy. The boilers are large—78 inches diameter—with steam drum located in smoke-box. They carry 135 pounds steam pressure, which drives a triple expansion Riedler pumping engine furnishing water under pressure to the draw-benches where the high carbon and nickel-steel tubes are made for bicycle frames. Water is supplied to these boilers by duplex pumps having two new features: an attached water meter, and wooden lagging on the steam cylinders. Coal is dumped from the cars into a hopper, elevated either into bins above the boilers, from which it is fed through an automatic weighing device into the automatic stokers, or it is dumped into the bunkers with hopper bottoms, from which it can be drawn into the conveyor, which returns under the bunkers at any time, and charged into the boiler bins. This conveyor also returns under the boiler ash-pit, with which it is connected by sliding gates, thus carrying away the ashes and dropping them into cars. Before going into the automatic stoker, the coal passes around the smoke box of the boiler, thus becoming quite dry before entering the fire-place. The continuous-belt grate runs on friction rollers and is propelled by the mechanism just described. Blast is furnished by a fan whose speed is regulated by the steam pressure; when the pressure is too high the blast shuts off and the fire dies down. One man is expected to attend to six boilers. As all steam is condensed and the water returned to boiler, the opportunity is taken advantage of to save all the oil drips by means of a separator. Drums for superheating steam will be used, and as superheated steam was found to corrode iron pipes, bronze pipe will be employed. There will be no Brussels carpet on the floors, but simply tinted silicated cement on a concrete foundation.

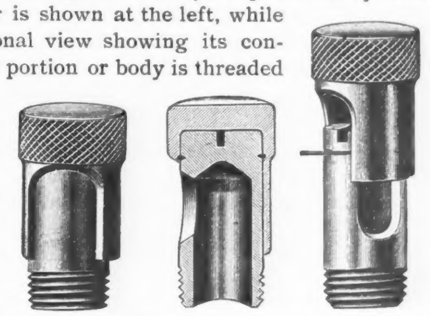
It has been proven that each of the devices mentioned are economical in themselves, and it will be interesting to note whether they will be equally so when put together. The speed reducer described is excellent in connection with a grate, but whether it will be equally so on a traveling crane, or a revolution corrector, I will not say, but suggest the policy adopted by the company using it, which is best expressed in a phrase used a famous Boston lecturer, "Learn how to do a thing by doing it." In other words, if you want to know how a thing found good in one place will work in another—try it.

* * *

OIL-HOLE COVERS.

One of the little wrinkles which help to smooth out some of the roughness in the machine builders' path is a good way to keep the dust *out* of oil-holes and the oil *in* them. The pine plug may do in a measure, but it's unhandy and doesn't make a machine look stylish, to say the least. The dust-proof oil-hole covers shown are the latest devices of the kind on the market, and are exceptionally neat, having no projecting screw, as in the older forms by this maker, although these may be preferred by some

The complete cover is shown at the left, while next to it is a sectional view showing its construction. The inner portion or body is threaded at the lower end and is screwed into place by screw-driver, as shown by slot in top. The cover, which is heavily knurled, slips down over the body, and is held by the small round spring of music wire shown better in the view at the right. The spring fits half in body and half in cover, and prevents the cover coming off accidentally as well as from being jarred open when not wanted. The opening for oil can spout is ample, and they form a very handy device, which is being used extensively by the large builders. They are made by F. D. Winkley, Madison, Wisconsin.



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THE BLOWING OUT OF BOILERS.

W. A. Carlile.

Most people, if asked what a blow-out arrangement on a boiler was for, would say it was to blow water out of the boiler. But this is not its primary function, which is to blow out deposit and not water. Unfortunately, the water insists on accompanying the mud, and as it goes, carries its heat with it. This comes to the same thing as blowing out money into the drain. Every well set boiler slopes down to the blow-out. The object is to entice the mud to settle at that end where it can be coerced or cajoled into taking itself elsewhere.

When a boiler is at work, the loose deposit circulates with the water, and blowing out can do little good. Even at the best, comparatively little of the deposit is removed by blowing out. If the blow-out plate be examined after the boiler is stopped, it will be found that an area of about two feet diameter is fairly clean, but all the rest of the deposit along the bottom seems to be practically unaffected. Yet in cases where this examination is made, we know that not a part only, but all the water has been blown out in order to empty the boiler. But though heat goes out with scale, yet in the profit and loss account occasional blowing out leaves a balance on the right side.

The best time for blowing out is before the boiler is set to work in the morning. During the night the deposit has had time to settle. The temperature of the water is also at its lowest, and therefore at this time there is less loss of heat with the water blown out. As with banked fires, the water is usually pumped in over night to the top of the glass, so in the morning there is too much water. This has to be removed in any case, so as to avoid priming. Therefore by blowing out for a few minutes in the morning there is practically no loss of heat which can be avoided. Blowing out for two or three minutes before the end of the dinner hour also helps to keep the boiler free from loose deposit.

There are several ways in which blow-out pipes are attached to boilers, and each method has advantages and disadvantages. With vertical boilers or with those of the locomotive type, there is not much variety in the blow-out arrangement. The tap is put as low as possible, and beyond that little remains to be said or done.

Horizontal boilers with internal tubes usually have the blow-out pipe at the front of the shell at the bottom. A block is riveted on the shell. The blow-out bend is bolted to this, and at the outer end of the bend the tap is attached. But with a pipe in this position there is always a danger of binding. But with a pipe bound, and a boiler creeping backwards and forwards as it expands and contracts, there is a danger of fracture. With externally fired boilers, such as the egg-end type, the blow-out pipe is attached to the back end, for at the front end the fire is in the way. In order to prevent the hot gases from getting at it, brickwork is built round the pipe. The pipe passes down through this brickwork, then bends to a horizontal position and passes out through the side or back end wall. In such a case the boiler is made to slope down to the back end. There is no particular advantage in this position of pipe. It is simply a necessity, as long as the blow-out is attached to the bottom. Its disadvantage is that a considerable part of the pipe is hidden in brickwork.

Two results follow from such hiding of the pipe. In the first place if the pipe corrodes on account of damp getting to it, the corrosion cannot be seen. In the second place, if there is any dampness in the neighborhood of the pipe, it is absorbed by capillary attraction in the brickwork and then held up against the pipe, so as to give it a chance to do its mischievous work. To avoid these dangers, frequent baring of the pipe is necessary for inspection, but as a considerable amount of brickwork has to be removed on these occasions, expense is incurred.

A third method of attachment of blow-out pipe is to have the tap on the top of the boiler. It is connected to a pipe which runs down to the bottom of the boiler internally. With an externally fired boiler this method is better than the last mentioned, but with an internally fired boiler it is seldom resorted to. The blow-out at the front is used instead.

One reason for its non-adoption in Lancashire and Cornish boilers is because of the greater length of piping that it requires. There is not only an internal pipe, but an external one is also required, in order to carry the waste water away. But with externally fired boilers the blow-out at the bottom, with its hidden pipe, is so bad an arrangement that the blow-out tap on the top is better. The faults of this method are three-fold, but none of the defects are serious ones. In the first place there must always be a space between the bottom of the pipe and the bottom of the shell. Thus the deposit in the lowest part of the boiler is left undisturbed.

The second fault is the extra piping already spoken of, with its accompanying extra cost. This is, however, a small matter. The third fault only exists when for some reason the waste pipe of the blow-out cannot be made to discharge low enough. If the end of the pipe is higher than the bottom of the boiler, then if the boiler happens to get cold with the water in, there are no means by which it can be easily emptied.

By balancing these three methods we may conclude that with a Lancashire or Cornish boiler the blow-out is most effective when attached to the bottom of the shell at front, while with externally fired boilers an internal pipe with blow-out tap on top is the best of the three methods. The arrangement with the blow-out pipe passing through a side wall is bad in every way. It may be cheaper to fix up in the first case, but as a rule it is the dearest in the end. It may therefore be ruled out of court.

The fourth method, which we have yet to consider, is one which appears to be very suitable for externally fired boilers. With Cornish or one-flued boilers it is unsuitable, and with Lancashire or two-flued boilers it is not superior to the usual arrangement of blow-out at the front; but it may be applied with advantage to externally fired boilers. By this method there is a valve-seat at the bottom of the boiler internally. The valve that covers the openings is connected to a rod which passes up through the top of the boiler. At the top end the rod is screwed, and a hand-wheel above the boiler completes the arrangement. By turning this wheel the rod is raised or lowered, and the valve consequently opened and shut. The external waste pipe that carries away the water which is blown out is never under pressure, except the small pressure of exhaust. Consequently it does not matter much if it is hidden in brickwork. Even if it is badly corroded, no danger can arise from this cause, for the full boiler pressure is never within it.

The only fault that is attached to this method of blowing out is the possibility of grit getting under the valve and preventing it closing properly. As a matter of fact, however, this contingency rarely makes itself known, and if it does appear, by opening and partially closing the valve once or twice, the obstruction gets blown out and the valve becomes perfectly tight.

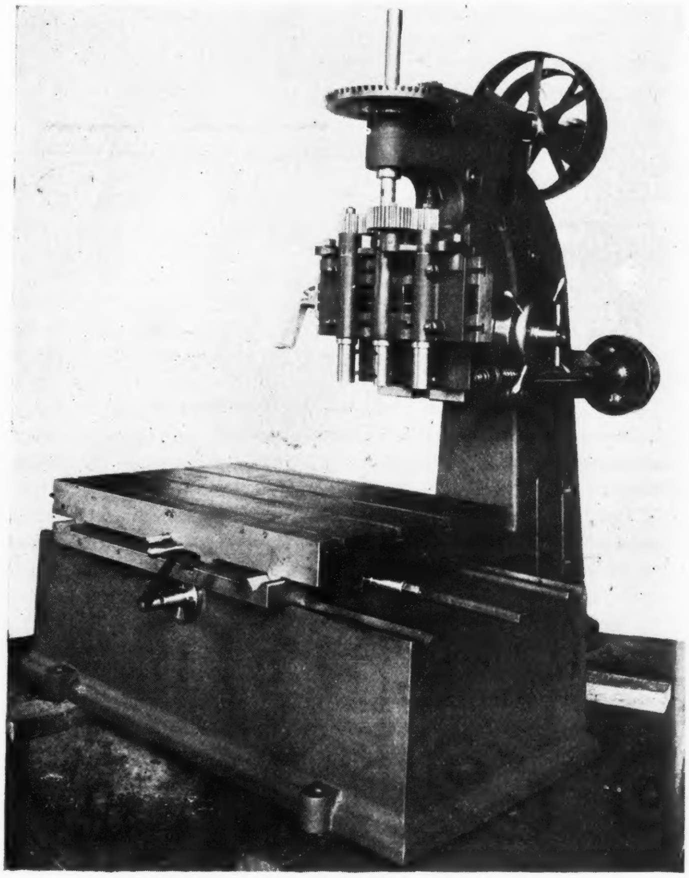
* * *

TWO SPECIAL DRILLING MACHINES.

We illustrate a six spindle brake lever drilling machine built by Newton Machine Tool Works, of Philadelphia, for drilling the holes in one or two brake levers at one operation. The six heads on rail can be set at any distance apart to suit the three holes in two brake levers for freight cars, and where four holes are placed in the brake lever one lever can be drilled at a time, using only the four spindles. The spindles of this machine are driven with phosphor bronze and Harveyized steel spiral gearing. The spindles have an adjustable socket to suit the different lengths of drills. The work table is fed upwards to the drills, having three changes of automatic feed with the quick return. The work table has a drip pan surrounding it for retaining the lubricant for the drills. The design of this machine is very plain, and it is made substantial and heavy to adapt it to the rough handling necessary in this class of work. This drilling machine is also made with three and four spindles for drilling one brake lever at

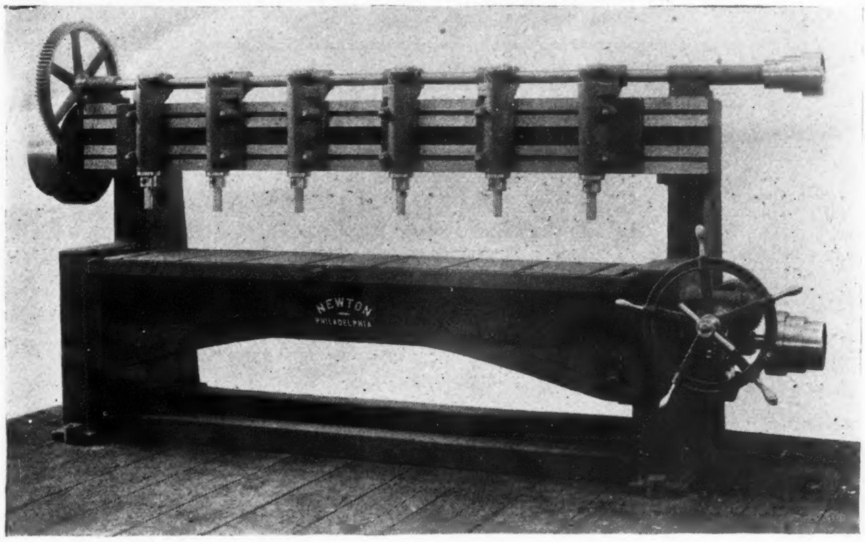
a time. The same design can be used for various other classes of multiple drilling where the holes are all of the same depth and diameter, allowing the work to be fed to the drills instead of having an independent feed for each drill.

We also show with this a special three-spindle multiple drilling machine, built by the same company. This machine was origin-



THREE SPINDLE SPECIAL DRILLING MACHINE.

ally designed for drilling the holes in the bonnets of the Porter-Allen engine. The spindle-head, which has an automatic feed, is counter-weighted and has quick return by hand. On the slide are three spindles, the main spindle being stationary and driven with the bevel gearing and cone pulley, and transmits the power from the center to the other spindles by means of spur gearing, with intermediate gears, which are hung on links, allowing the



SIX SPINDLE SPECIAL DRILLING MACHINE.

spindles to be adjustable within the range, which is from 3½ inch to 9 inch centers. With this method of driving, very close centers can be obtained and the gears can be made of broad face, giving the required power and strength desired for heavy duty. All three spindles feed downward together on the saddle, and have for different lengths of drills adjustable sockets with straight shanks, which fit in the nose of the spindle. The carriages of this machine are made to conform with the work to be drilled. The bottom saddle rests on ways on the frame of the machine, and has a rack for quick movement. The second saddle also rests on ways on the first saddle, giving the compound movement of both carriages. The top saddle is pivoted on the intermediate carriage, allowing it to be swung around and clamped in any position. With this method of drilling the bonnet, the three spindles can be set at suitable distances apart, and the three holes are drilled at one time and the carriage quickly racked over to suit the next set of three holes. The top carriage is then swung half way around and the other carriage can be racked in the opposite direction to accommodate the holes in the side. By this means all the holes can be quickly drilled with one clamping, drilling three holes at one time. The machine is very strong and powerful and adapted to very heavy work. While this design was made particularly for this class of work, the same can be carried out for many different classes of work.

* * *

NOTES FROM NOTOWN—14.

ICHABOD PODUNK.

CHANGE IN GRANGER'S SHOP—THE TOOLS AND THE TOOL MAKER. THE FOUNDRY.

There have been several changes in town this month and it looks as though some of the old concerns had been taking the Keeley cure or some other elixir of life; don't know what started them up, unless it was the competition of the new firm in the brass line who seemed to be getting a good share of the work of this vicinity.

Mr. B. has often remarked to me that he didn't see how old Granger ever made a cent, yet he seemed to get along and he made money enough to own several houses. Granger's brother was a born mechanic—at least so he said—and often remarked that he "*picked* his trade up, any one could *learn* a trade without half trying."

The trouble was he didn't pick up enough nor of the right kind, but he was a peaceable chap, didn't interfere with any one else and didn't do any more work than he actually had to, and that wasn't much. Now, if Brother Granger had been one of the lathe hands and his leisurely manner of working hadn't delayed any one else, no one would have been the wiser, but he was supposed to be the tool maker, and in a brass shop with lots of turret lathes, that means either dollars saved or lost for the firm—lost in this case.

One of the first essentials in this kind of work is to have the tools already for the turret men to go on with, or the time lost goes a good ways toward offsetting the advantage of these machines. Brother Granger, however, didn't seem to realize this, and the work was often blocked by not having the tools made or repaired, as the case might be, owing possibly to a prolonged nap when the boss was away, as his meekness often took this kind of a turn.

One of these naps is worth telling about, for although it isn't exactly mechanical, it illustrates the law of gravitation as much as Newton's apple, and perhaps the editor will let it pass on that score. The boss was away and Brother G. wended his way to the roof and laid down for a snooze in the shade. The roof was built with the front portion about four feet higher than the back, and both being nearly flat, this made a drop of about this distance in the center. The sleeper occupied the higher portion so as to be in the shade. What his dreams were no one can tell, but a violent move brought him to the edge and the next instant there was a thud, then a yell and the ex-sleeper was trying to convince himself that he wasn't dead and hadn't fallen to the ground below, while to the astonished shopmates he told a wondrous tale of dizziness while walking on the roof. This fall was what caused the change I mentioned and Brother G., while he makes tools, does so under the direction of a real tool maker who makes him get out the work on time, or knows why in a hurry.

Our Mr. B. was over there the other day and the new man wanted to know what he would give for all the tools they had. Mr. B. said he must weigh them first, then he'd pay him the regular scrap price, which wasn't resented, as the new man knew he was right and Brother G's. meekness prevented him from making any objection—"really too lazy to kick," Mr. B. said.

Now when there is any new work to be done, the foreman gives the new tool maker a piece of the work and he gets out tools for it; the tools are made in duplicate, if they are liable to be broken, and in any case duplicate cutters are made where practical, as it saves time in case of breakage.

It used to be that when old Granger sent up an order to have a lot of grease cups made and he would ask when they would be done, the foreman would reply: "Don't know, we'll start on them soon as we can get the tools. 'Twill take two days after we *start.*"

It was no unusual thing to see a boy spend halt a day cleaning his lathe just because he didn't want the boss to see him idle, and all the while he'd be waiting for tools. But Brother G. hadn't learned or, what was worse, didn't care—that it is keeping men at work by keeping them supplied with tools and materials that hurries along the work, and there was lots of time lost in this way. Then he had no system for keeping them, couldn't tell whether a tool was in working order or not without pawing over a lot of alleged tools and arbors, and after he found them didn't know whether they were right or not without trying them in a finished piece—not always then. It's different now, and I expect to see Granger building new houses by the dozen before long.

Granger's foundry is almost as bad as his tool room was before the revolution, and there's no chance of an earthquake here for sometime yet. Granger asked our Mr. B. about this last week and his answer was good, as usual, but the change would cost more than the tool room did and isn't to be thought of this year—even though it would pay for itself in a short time.

Granger asks things rather bluntly, and he said: "Do you think Dick is a good foundryman Mr. B.?" "No, I don't," said Mr. B. "Who can you recommend, Mr. B.?" "No one, at least not with your present equipment. Why, Mr. Granger, a really good man wouldn't stay in such a hole as that anyhow. I don't think Dick is the best foundryman I ever saw, but he gets more out of the things he has to work with than many better men would. You haven't got a decent tool in the foundry anyhow. The grinder would give a man delirium tremens, the rumbler is nothing but an old dirt catcher at best, that doesn't half clean castings (I *know* this—I had some from you the other day) or do much besides make a racket, and your furnaces are inconvenient to say the least." "Well," Mr. B., "you talk plainly anyhow and maybe your right, but it won't do to have too much changing at once or the old place wouldn't know itself. I'll think it over though. But you forgot that we have an ash chute from the furnace, Mr. B., give me credit for one good thing at least." "I'd be glad to, Granger, if it had ever been used, but as it was nothing but a rough old chimney to begin with, it packed full as soon as ashes went into it. Ask Dick, or the boy who hustles the ashes out what he thinks of the chute, Mr. Granger, and I guess you'll admit even that isn't a howling success." I don't know whether Granger will do anything in the foundry matter or not, but after the other change anything is possible.

* * *

ABOUT WIDE BELTS.

Samuel Webber.

I have read Mr. Cheney's notes on width of belts in the September issue, and while he is entirely correct in what he says, I do not think he gives the real reason for using wide belts, quite fully enough, though he mentions the *strength* rather than the *width*, as being the controlling element The safe strain on leather belts (single) is variously estimated at from 45 to 66 pounds.

I follow Morin, in taking it at 330 pounds per square inch, and as a "single" belt is usually about $\frac{1}{6}$ inch thick, call it $\frac{330}{6}=55$ pounds. Now a horse power is 550 pounds raised 1 foot per second, and therefore a belt to transmit it at that speed should be $\frac{550}{55}=10$ inches wide. If the belt moves ten times as fast, or 600 feet per minute, 1 inch in width will transmit this power. This, be it understood, refers to cemented belts, running steadily in one position. If it is a narrow, laced belt, liable to the constant extra strain of stopping and starting machines, I should add 50 per cent to this, and call it 900 feet per minute per HP. When a narrow belt will not drive a machine steadily, it is often the result of stretching and slipping, so that it does not cling to the pulley closely, while a wider belt which does not stretch, will keep its hold on the pulley and drive it up to speed, although the power required for the machine is the same in either case.

Here is where the advantage of a wide belt comes in, not to transmit more "intrinsic" power, but to transmit the necessary power without loss, due to the insufficiency of the belt itself.

A round belt of equal area will pull more than a flat one, from the extra friction caused by wedging in the grooves of the pulley. If the groove is semi-circular, it will not do it.

The great point in using belting is to proportion the width to the load, and the load to the strength and thickness of the belt.

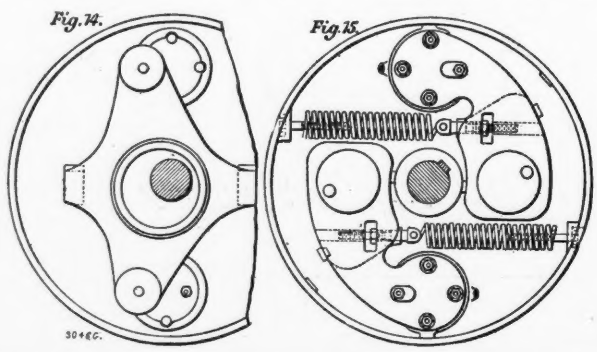
High speed, narrow belts have been the rule in the cotton mills of New England for many years, and shafting which within my recollection was turned at from 122 to 150 revolutions per minute, now runs from 300 to 400 revolutions.

* * *

DETAILS OF GOVERNOR—UNIVERSAL HIGH-SPEED ENGINE.

In response to inquiries we have obtained the following details of the governor of this engine, which we illustrated in the August issue:

The high-pressure valve is operated by an eccentric under the control of a shaft governor, while the low-pressure valve is worked by an eccentric with a fixed stroke. The governor (Figs. 14 and



15) is the outcome of a large number of experiments made to arrive at a design which gives a firm control of the valve under all conditions, and which will stand the wear and tear to which it is subjected. When it is desirable to alter the speed of the dynamo during the run, the governor is fitted with Raworth's speeder gear (illustrated in Fig. 16), by which the tension of a spring can be regulated without stopping the engine. It is the supplementary spring shown that is regulated. One end of it is attached to an eccentric strap fitted to an eccentric loose on its axis This eccentric has a spur-wheel attached to it, and beside it is another spur-wheel fast on the shaft. A fixed frame carries two pairs of differential pinions, and this frame can be moved to put either pair of wheels in gear with the wheel on the shaft, and to transmit the motion to the wheel on the eccentric. By this means the eccentric, which is not the main eccentric, but merely a device for tightening or slackening the supplementary spring, can be rotated in either direction relatively to the governor disc.

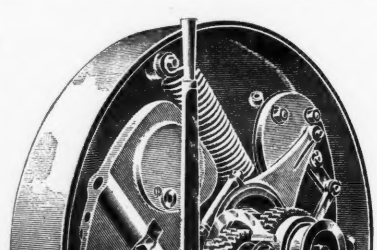


FIG. 16.

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We are constantly receiving inquiries about various kinds of machinery, and would like to keep the latest catalogs of machinery builders on file for reference. Please send us yours.

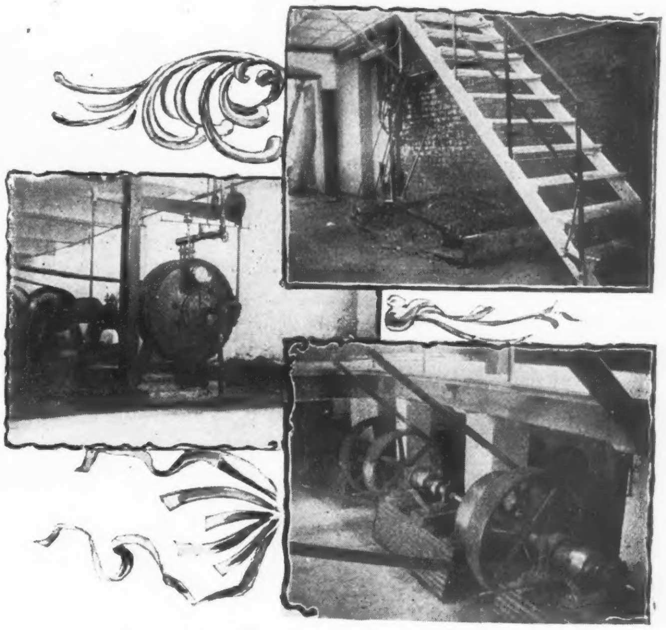
AT THE WORCESTER "TECH."

In addition to the interesting power plant of the Worcester "Tech," as the Worcester Poly.echnic Institute is affectionately called by all graduates and Worcesterites in general, there are many other features worthy of mention. The small views in the group are the results of pressing the button, and doing the rest, too, with a pocket kodak, and are almost self-explanatory. These stairs are about the easiest to climb of any iron ones the writer ever tackled; the treads are made of comparatively light iron and have just enough "give" to them to be comfortable, and they are not too steep, either.

The next view shows one of Prof. G. I. Alden's dynamometers, which is on the end of a secondary shaft, behind the jack shaft. This brake consists essentially of cast iron discs, which are connected to the secondary shaft by a clutch. These iron discs revolve between copper discs which are fastened to the dynamometer case and which are really copper diaphragms. These are pressed against the revolving discs by water pressure, as indicated on the gage shown; the water serving the double purpose of applying pressure and of absorbing and carrying off the heat generated. The power absoibed is measured by the weights on the lever shown over the top, which weighs the power in the usual way of absorption dynamometers. This machine has a capacity of 150 horse power. In the transmission from the jack shaft to the secondary shaft three kinds of belting are employed: the regular oak tanned leather, the leather link and a camels' hair belt. This last is a comparatively new fabric for power transmission, having been on the market but a few years. It is apparently a good belt, but its fastenings, in this case at least, can hardly be commended for safety to the attendants, although they doubtless hold the belt firmly, which is perhaps their main object. The outside fastenings are malleable iron straps, which are held on by bolts from underneath and nuts on the outside, the nut and the portion of the bolt left above it, projecting probably ⅝ or ¾ of an inch above the belt. At a speed of possibly 2 500 feet per minute this makes a discouraging thing to come in contact with, and while no one *should* be near enough to be struck, it is pretty sure to scalp or otherwise maim some one, if it is used and left unprotected. When it is necessary to have such an arrangement for fastening the belt there should be coverings provided which make contact impossible in walking around or near the belt.

The Putnam engine before mentioned is about the nicest piece of work in the way of an engine that the writer has ever seen, and while it probably does not run any better for its extra finish, it is pleasing to see it in a plant of this kind.

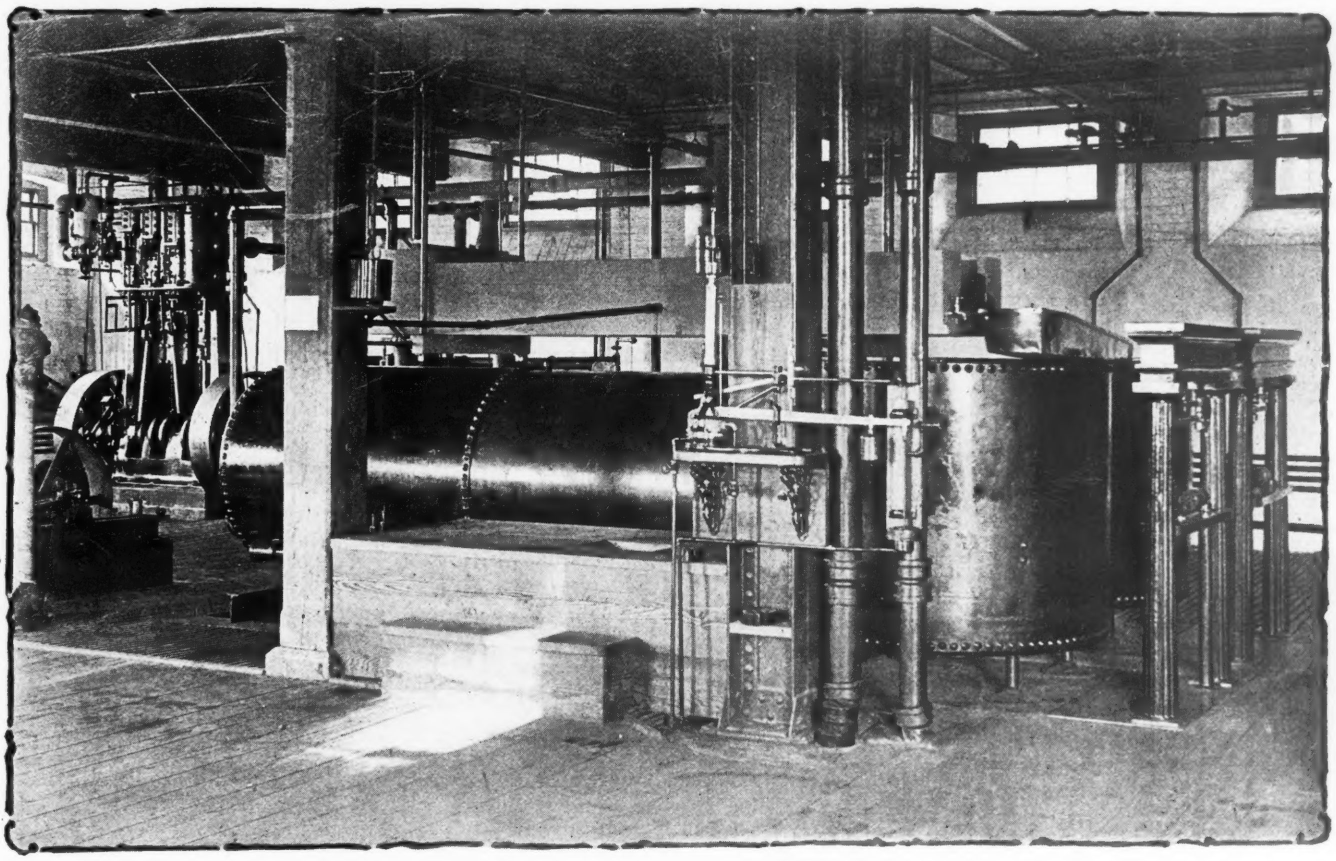
The receivers between the different engines are divided into



FIRE ROOM STEPS—ALDEN DYNAMOMETER—JACK SHAFT.

sections so as to determine the results of receivers having different volumes. The heads and barrels of cylinders are steam jacketed separately, so that either can be used or none at all. The Putnam governor has a very neat arrangement of change gears with a sliding feather, similar to the feed of a lathe, by which four changes of speed can be obtained The Reynolds-Corliss varies its speed by a spring arrangement on the governor which controls the cut-off. The Wheelock engine, with the latest valve gear of this company, has three steps on the governor pullies for the belt.

These variations allow a great variety of changes in the ratios



HYDRAULIC TESTING PLANT, WORCESTER POLYTECHNIC INSTITUTE.

of cylinders, as it is evident that if the low pressure engine runs 50 per cent faster than the high pressure engine, it is equivalent to having 50 per cent. greater cylinder volume than it would at the same speed, thus making an almost endless variation of ratios possible.

Part of the hydraulic plant at the school is shown in the large view; the water power at Chaffinsville, five miles distant, was mentioned in the last issue. The one shown consists of a large tank, pumps and weighing tanks, as will be seen. The box-like arrangement over the large tank has a "weir" at the right, for instruction in measuring water by this method, and the weighing tanks can be used to check measurements.

At the extreme left is one of Prof. Alden's triple expansion engines, which has but one valve, this being on the high pressure cylinder. The high pressure piston forms the valve for the intermediate cylinder, whose piston in turn forms the valve for the low pressure cylinder; a very ingenious device, but not one calculated to stand the commercial test.

In the same room is a 100 000 pound testing machine of the "Emery" type, built by William Sellers & Co., of Philadelphia, and is of the same general design as the larger one at the Watertown Arsenal, as described elsewhere in this issue. This is known as a 100 000 pound machine, being capable of testing in compression specimens 12 feet long, and in tension 8 feet 4 inches long, up to its capacity.

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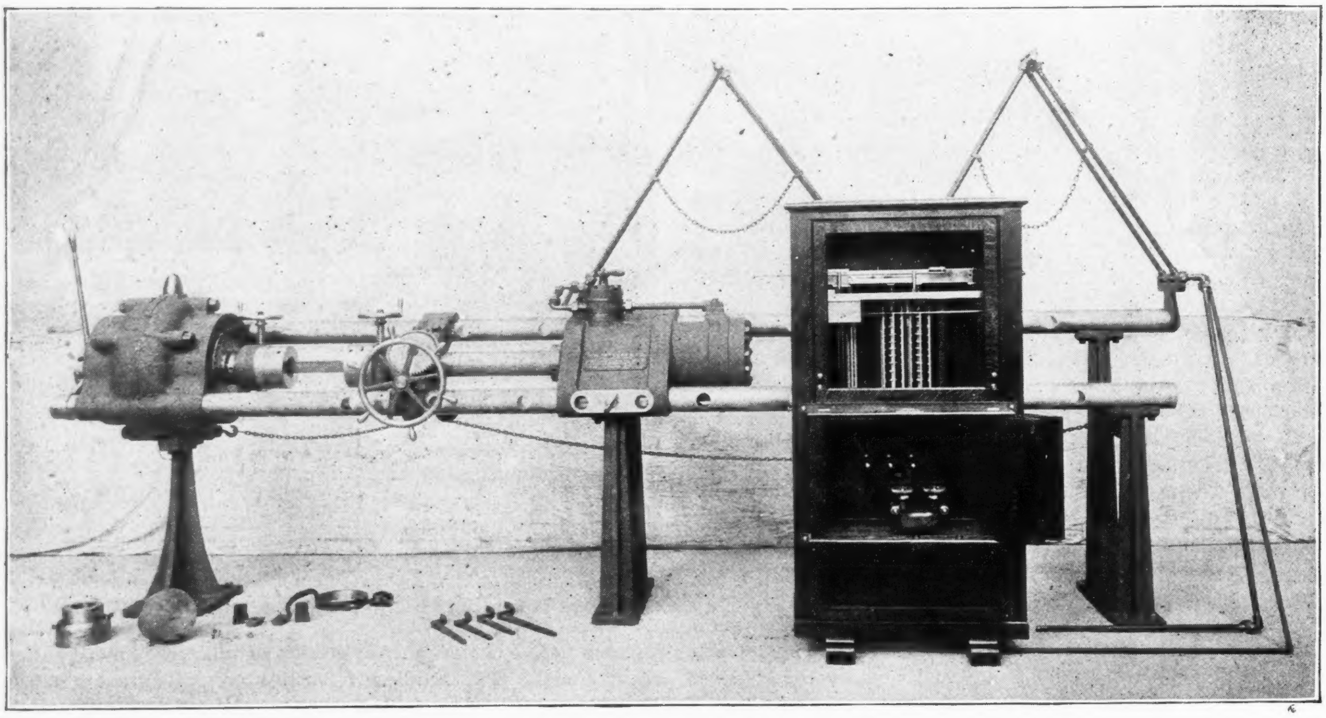
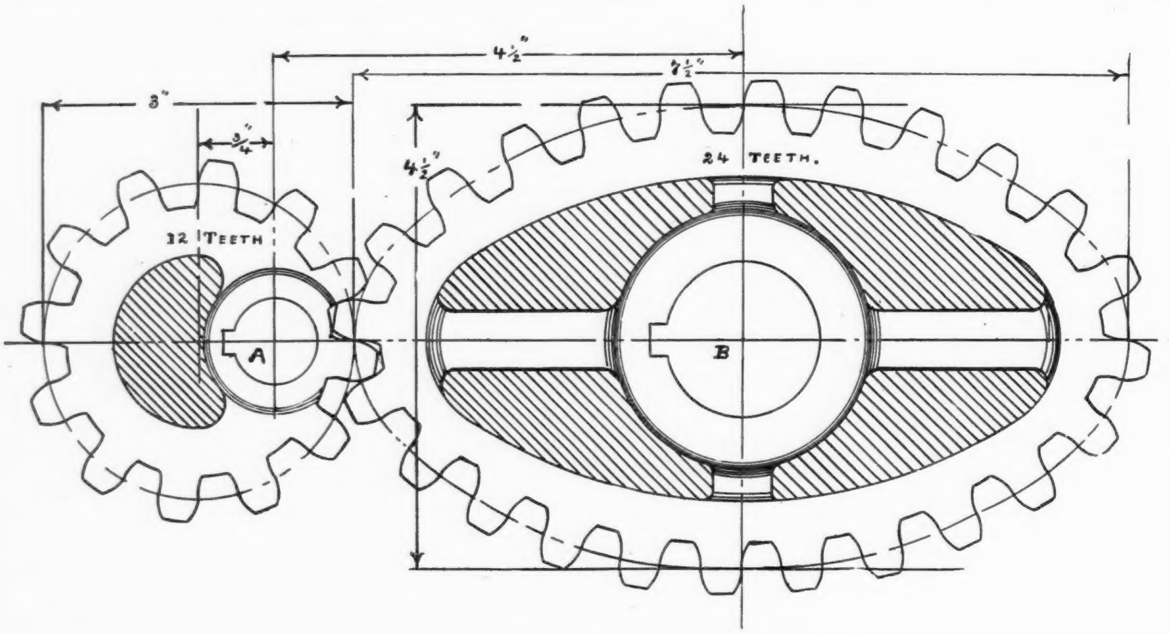


100,000 POUND "EMERY" TESTING MACHINE AT THE WORCESTER "TECH.," BUILT BY WILLIAM SELLERS & CO.

ANOTHER CHAPTER IN GEAR-OLOGY.

F. W. Clough.

The cut shows an eccentric gear driving its mate, an elliptic gear, an average ratio of speed 2 to 1; and yet accelerating and retarding speed in parts of each one half revolution, while the driving shaft A runs at a uniform rate of speed. The shaft B, when elliptic gear is in contact at its two largest radii with the smallest radius of eccentric gear, is driven at $\frac{1}{5}$ the speed of A; but when the throw of eccentric gear reaches in revolution the two smallest radii of elliptic gear, then the speed of shaft A and shaft B are equal. Sometimes this differential from uniform rotation of shaft is wanted in machine design employing gears. To lay out and cut this pair of wheels so that they will run free and with good contact requires a good understanding of principles involved in their form. It will be observed that the teeth of elliptic gears cannot be cut with one ordinary space cutter; so if the teeth are cut, other mechanical means must be used to conjugate the teeth. Ordinary eccentric or elliptic gears are cast from pattern; even then the same principles are to be observed in constructing patterns correct.



ANOTHER CHAPTER IN GEAR-OLOGY.

ENGINEERING NOTES.

J. Richards.

It is amusing to observe the vigor with which electrical folks attack any proposition of power transmission by compressed air, as in the case of Mr. Foote's paper read at the late meeting of the American Society of Civil Engineers at San Francisco.

It is not profitable and perhaps illogical to "take sides" in a controversy over different methods of power transmission without assuming particular applications, because steam, water, air and electricity, all have their places and adaptations, but there are certain disputed fields in which inferences are much more reliable than statements.

Electric transmission may be said to be mainly in the hands of zealous young college people, and promoted by ponderous corporations, so it is set forth and urged by all the arts known to trade and technical enthusiasm, while pneumatic transmission is dealt with mainly by conservative highly skilled engineers devoid of enthusiasm, feeling their way carefully, proving the ground as they go. They do not call air a "power" and compare it with steam engines as our electrical friends do, but speak of it as a medium of transmission which like electricity it is, and nothing more.

There is a widespread opinion, engendered by careless terms, that a railway or a factory may be driven by "electric power." It is constantly so stated, and electricity put in comparison with steam and water power, when the true comparison is with belts, shafts, air or other elements of transmission.

By assuming certain functions or purposes, comparison becomes possible; and, as before remarked, inference rather than alleged facts is the safest guide to future practice. In respect to railway traction and for long transmission, the pneumatic system is newer or later than the electric current. It is true that in respect to age, air transmission is much older, but going back ten years we will find claims were made of 80 per cent. efficiency for electric transmission when no one claimed more than half as much for air. At the present time electricity has gained 10 per cent., and under favorable conditions conveys energy with 90 per cent. efficiency. The air system during the same time has gained from time to time much more in proportion, and now stands abreast of electricity on the score of efficiency.

Stage compression, reheating and improved valve action with a more complete knowledge of the thermal conditions and losses has wholly changed the art of pneumatic transmission, but so suddenly that there is no popular knowledge of what has been accomplished.

A hundred street cars are now operated in Paris by compressed air. These cars are "automobile," carry fifty persons each, are said to cost but eight cents a mile for traction. The time of charging by the Merskaski system is two and a half minutes and the scheme is permanent and satisfactory. Paris is the home of air transmission, the distribution of power there by pneumatic means is one of the great engineering facts of our time, aggregating 15,000 horse power and with a record of a dozen years, all the time gaining in favor and efficiency. The Hardie and Hoadley are about being tried in this country, and it is not easy to predict what the result will be commercially, but as to safety, convenience, and good service to the public, there is no question.

Operatively there are several distinctions between air and electricity. Air can be applied directly to produce rectilinear movement, as in the case of hoists, presses, and also can be applied to steam engines *en situ*, while the electric current must pass through rotative machinery for all power purposes. This enables direct application to all rotative machines, by far the most numerous; but the same function is open to air by means of impulse wheels, so little known at this time however, that not much has been done in that direction.

The losses by line and pipe transmission are hard to compare. They are tolerably well known in so far as computation, but actual results are not easily arrived at; there are incentives to conceal such losses, and reports are far from reliable.

With air the Unwin formula shows for fractional resistance in pipes 5 inches in diameter and pressure of 70 pounds per inch, a loss of 4.6 pounds for one mile and 9.4 pounds for two miles, increasing to 26 3 pounds at five miles.

Riedler applies the same rule as in the case of "electric currents," that is: the resistance directly as length and inversely as diameter or area. Assuming this rule, gives to electric transmission an advantage for long distances both as to loss of energy and the cost of lines for conveyance. In mine or underground transmission the pneumatic system will, no doubt, have preference. It can be more directly applied, supplies in part ventilation and cooling, and is less dangerous and more easily managed by the men.

The ideal steam engine, to consume one pound of coal per hour for each horse power, has long been on the way but is now near at hand, in a plain commercial engine made to order under a promise of consuming 1.15 pounds of coal and actually burning only 1.07 pounds in propelling a ship of 5 000 tons. Messrs. Gray & Co., of Hartlepool, England, made the engine for the ship *Inchmore*, and on one run the performance actually went under the pound of coal, the footings showing .999. This engine, beside the furtherance of all the minor economies, has the feature of five cylinders and cranks by which the reciprocating weights are much reduced and the turning moments on the shaft practically uniform. The boilers, which are a principal element in the case, were worked at a pressure of 225 pounds and had been tested to 510 pounds, so there can be no difficulty in making Scotch shells to stand all the required strains. Aside from some laboratory tests and very few of these, this is no doubt the best result attained. The water consumption is not given, and if it were the result would not be indicated thereby, the true test is a fuel one. [Prophecy is cheap, also is dangerous in the mechanical arts, but it requires no great boldness to predict that within five years contracts will be made for engines guaranteed to develop a horse power with one pound of coal per hour].

* * *

A FEW "HOW TO DO ITS."

F. H. Jackson.

The following devices have been in actual shop use for sometime and have given perfect satisfaction, and will, no doubt, be found labor-saving to a great many machinists in small establishments, where the purchase of the more modern tools for similar purposes would not be warranted.

The centering tool shown in Fig. 1 consists of a *fac-simile* of the mandrel nose (lathe spindle) with a hole lengthwise through the same in which a nicely fitted center-punch is placed. To use this device, take a chuck that fits the lathe and screw the jaws on

Fig. 1

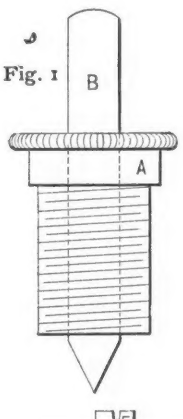


Fig. 2

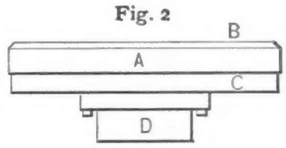
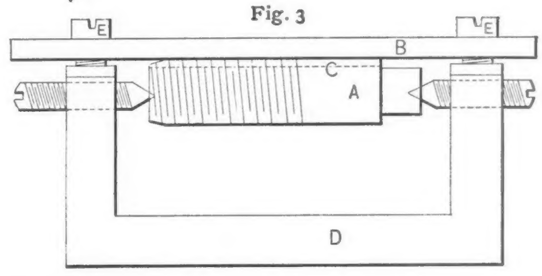


Fig. 3



the piece you wish to center, then screw into face-plate on chuck the piece A, place punch in hole and give it a gentle tap, and if your chuck and point of punch are true, the piece will be truly centered.

Fig. 2 represents an emery grinding disc, which is one of the most handy tools to have about a lathe. A small face-plate is fitted to a round wooden block, the same being accurately turned with a slight bevel on edge of face side. A band of heavy tin or light sheet iron is made to fit the edge of disc C, as shown by A, a little loosely. Place a sheet of emery paper of proper grade on face of disc and force on the band A, and you will have an emery

grinder that will discount many more expensive tools. Lathe tools can be very accurately ground with this device, and for facing up small pieces and tools it will be found a very desirable addition to any lathe.

All small shops are not supplied with machines suitable to mill out the grooves in taps, and the simple device shown in Fig. 3 will greatly assist the machinist when he wishes to make an odd tap or two. A frame shown by D is made of machinery steel, in the upper ends of which are fitted centering screws as shown. On top of frame is placed a piece of an old flat file, B, which has been softened so holes can be drilled for the screws, E, and one edge of file teeth filed off; then the file is hardened as hard as fire and water will make it. The edge is polished, and to use the device place taps in frame between center screws, screw down the screws, E, so the tap will not turn and then file the groove to proper depth as indicated by the dotted line C. Of course, it must be understood that the piece B is so fitted to D that the edge of B is over the center of the tap, lengthways. A is a very poor representation of a tap, but it will illustrate the idea.

* * *

MANY of the mistakes that are made in calculating, designing and even in machine work are due to not knowing why the different operations are necessary. When the reason is known, any error is easily detected.

* * *

SETTING A SLIDE VALVE.—2.

F. F. HEMENWAY.

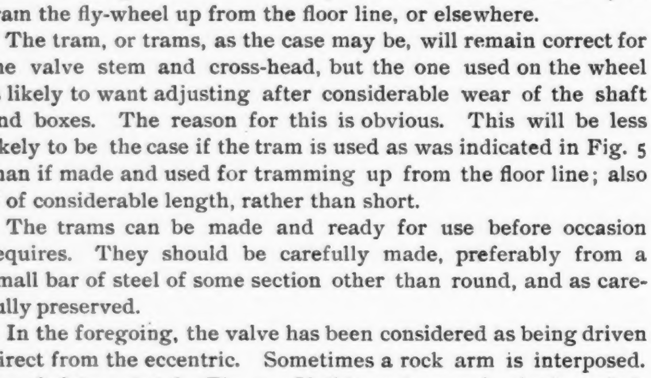
In bringing any of the trams to position let the last movement of shaft be, for a little distance, in the direction in which the engine is to run, so as to take up any slight lost motion there may be.

The trams need not of necessity be of the form shown; circumstances must govern this. It may be advisable or necessary to tram the fly-wheel up from the floor line, or elsewhere.

The tram, or trams, as the case may be, will remain correct for the valve stem and cross-head, but the one used on the wheel is likely to want adjusting after considerable wear of the shaft and boxes. The reason for this is obvious. This will be less likely to be the case if the tram is used as was indicated in Fig. 5 than if made and used for tramming up from the floor line; also if of considerable length, rather than short.

The trams can be made and ready for use before occasion requires. They should be carefully made, preferably from a small bar of steel of some section other than round, and as carefully preserved.

In the foregoing, the valve has been considered as being driven direct from the eccentric. Sometimes a rock arm is interposed. See skeleton sketch, Fig. 6. If this rock arm is single ended, serving simply as a carrier, the eccentric rod taking hold at s, the case will not be altered. If the rod is double ended, as indicated,



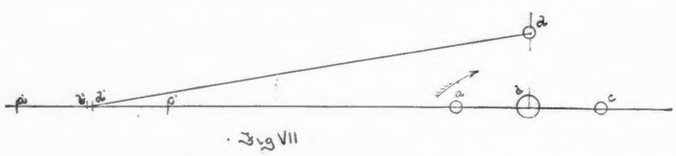
the eccentric rod taking hold at u and the valve rod at s, the same direction of revolution being maintained, it is evident that the heavy part of the eccentric must be on the other side of the shaft, the angular advance of the eccentric being laid off from a line y at right angles to the mean line of motion of the eccentric rod and in the direction of the revolution of the crank shaft.

A little study of the subject will make the approximate temporary location of the eccentric possible, no matter what the character of the rock arm or other connection between eccentric and valve may be.

I am aware that many will say that so much of refinement is unnecessary in ordinary valve setting, and equally well aware that it is. In locomotive practice, valves a "little out" means the cutting out of a car or two on the road of the always-too-long freight train, and worse than that with the fast passenger train. With the stationary engine it means buying and shoveling more coal than is necessary.

In reference to the lead desirable to be given a slide valve, a short-ported engine should have more lead than a long-ported one; but lead does not possess the importance usually attributed to it in the way of cushioning the piston. A little consideration of the fact that near the end of the stroke the valve is moving faster than the piston, will render the reason for this apparent. To make a strong attempt to materially check the piston, fly-wheel and attached machinery by excessive lead is too much like trying to do the same thing with a battering-ram. I mean by lead as ordinarily understood. As steam engines are generally constructed to-day, more than $\frac{1}{16}$ inch lead is usually excessive. This without much reference to what the size of the engine may be. Less is often better.

It is always possible to set a valve very well indeed without the use of the indicator, still it is advisable to use that instrument, especially after the engine has been running a few days since the valves were set. By a little practice in its use it becomes a valu-

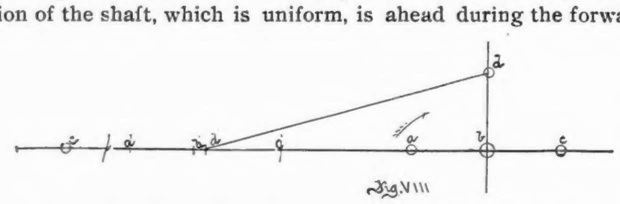


able assistant to the engineer in keeping the valves of his engine in proper adjustment. Any good work on the subject will give all the instruction necessary for its use in connection with valve setting.

The angularity of the connecting rod has a noticeable effect on the time of occurrence of the events controlled by the slide valve, as between the forward and the return stroke. Take the variation in the point of cut-off, for example. Figs. 7 and 8 are given not for the sake of argument, but as representing the existence of such a variation, and to indicate to the young engineer how he can satisfy himself, with very simple tools, not only of the existence of the irregularity referred to, but its extent.

In Fig. 7 the connecting rod is six cranks in length, which is good practice. In Fig. 8 it is four cranks in length. Now, by setting the trams at a radius of six cranks and tramming from centers a, b and c, the center line of motion will be cut at a', b' and c', b' being of course midway between a' and c'. But when the quarter-revolution point has been reached by the crank-pin to find the position of the cross-head, we must evidently tram from center d, the tram cutting the center line of motion at d'. The piston is evidently a distance b'-d' away from the lineal center of stroke.

Repeating this in Fig. 8, with the tram set at four cranks, the distance b'-d' is seen to be materially greater than in Fig. 6. The logical conclusion is that the piston referred to the revolution of the shaft, which is uniform, is ahead during the forward



stroke, and correspondingly behind during the return stroke, and that the extent of this irregularity is in inverse proportion to the length of the connecting rod. The cut-off, unless some means are taken to avoid it, will be later in the forward than in the return stoke. It will readily suggest itself that the irregularity at other positions than at half stroke (where it is greatest) can be easily sketched, and that doing so cannot fail of being instructive. Other events in the steam distribution are similarly affected, a matter of importance; but all are less so than might be expected in the instance of throttling engines, that seldom cut-off much earlier than at three-quarters stroke. They become of greater importance in the instance of a slide valve, the motion of which is automatically controlled by the governor.

To overcome this irregularity, Auchincloss, nearly thirty years ago, proposed* unequal lead, giving, in the way of illustration, indicator diagrams from an engine in which the cut-off was at $17\frac{1}{16}$ inch forward and $15\frac{3}{4}$ inch return stroke. To equalize the cut-off the valve was given $\frac{1}{2}$ inch lead for the forward and $\frac{1}{8}$ inch for the return stroke. An inspection of the diagrams taken

* Link and Valve Motion: Auchincloss.

The angularity of the eccentric rod will have an effect on the steam distribution, but for obvious reasons, this under conditions ordinarily met with, will be so slight as to require no consideration.

before the change with those taken after, does not reveal any advantages derived from it. The cut-off and exhaust closure and opening were fairly well equalized, and that appears to be about all there is to be said of it. Evidence from the diagrams that there was smoother running, or that steam was saved is lacking. However that may be, most steam engineers, while they favor equalized cut-off, do not do so at the expense of widely unequal lead. Should the engineer or machinist be desirous of experimenting with unequal lead he can readily do so by advancing the eccentric and lengthening the eccentric connection, keeping track of just what he is doing by the use of his trams.

It may be mentioned that equalized cut-off is maintained in the locomotive by the point of suspension of the link and the general co-relation of parts and points.

Professor Sweet accomplishes the same end in the Straight Line engine by a peculiar and ingenious arrangement of rock arm. Other builders employ different means.

There is another thing in connection with the operation of a slide valve by means of an eccentric that may sometimes be very serviceable. That is how the angular advance of the eccentric, to cover lap and lead, appeals to the sense of seeing. It is astonishing how near a slipped eccentric may, in an emergency, be put back near enough in correct position to cover the emergency, if its correct position is a part of the education of the eye. This position may be readily drawn, full size, on the floor, if no other conveniences are available, as follows: As an example, let the lap of valve be 1 inch, the lead be $\frac{1}{16}$ inch, the port be 1 inch and the travel be 4 inches, which is just sufficient to open the port fully.

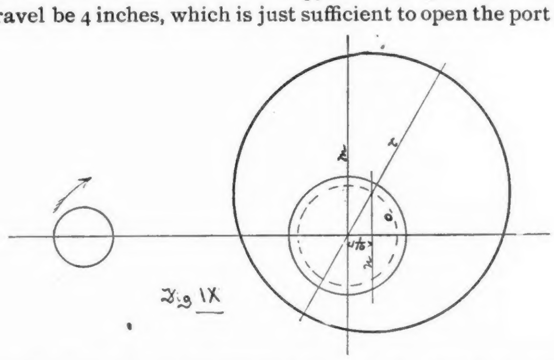


Fig IX

To find the position of eccentric when the engine is on the dead center, draw the line *m*, Fig. 9, at right angles to the center line of motion, and parallel to this draw the line *n* at a distance from it equal to the lap and lead of the valve, say $1\frac{1}{16}$ inch. Describe the circle *o* with the radius equal to one-half the travel of the valve; in this instance the radius will be 2 inches. Then draw the line *r* as indicated. Where this line and line *n* cut the circle *o* will be the center of the circle representing the outline of the eccentric. Observe this figure carefully. Have it where it can be seen occasionally. The number of degrees which the eccentric has been carried forward from *m* is called the angular advance.

* * *

TOO MUCH ROOM—NOT ROOM ENOUGH.

H. F. G.

How many men believe that there is no such thing as having too much shop room—space—in and around a machine shop. Mighty handy, they reason, to have plenty of room to store things out of the way of pedestrianism; things that may come handy sometime. Yes, they might continue, handy sometimes, perhaps, but unhandy and in the way all the time.

This is a little bit of my personal experience, with nothing but truth to recommend it. I had the good fortune to serve an apprenticeship in a nearly new shop and one of the best of its day. All the departments were roomy and light, but this was particularly true of the machine shop. The workmen were hardly near enough together to be neighbors. Notwithstanding this it was was about the worst shop to get around in that I ever saw, pieces and parts of machinery, complete and incomplete, everywhere. Lots of room and everything loose might just as well be around as not. Floor couldn't fall unless the solid earth gave way.

This "lots of room," in the course of time, just filled that machine shop till there wasn't space enough left to get around in respectable safety. There were a hundred things that you were morally certain you would never want, and the one or two that you did want could never be got at.

From this shop I went to work in one at a distance, doing very much the same kind of work with about the same number of men. The machine shop was no more than half as large, but there was plenty of room. To begin with, the shop was small and some one had arranged the machines and otherwise planned matters to the end of having plenty of room. Things had to be so planned or there wouldn't have been more than half room enough.

Still later on I worked in a shop with abundant room inside and a couple of spare acres of ground outside, and there were literally hundreds of tons of castings scattered over this ground, not one of which, with the exception of an occasional foundry flask, I ever saw put to any useful purpose. This, to say nothing of the everlasting litter about the shops; in the first and last instances there was so much room that there wasn't room enough.

There are a thousand shops in the land to-day that are in the same condition that these were; that are crowded for room, crowded for room when they would have room to rent if it were only utilized. What is wanted is a general rejuvenation, a clearing up and reorganizing process is the requisite. There are a dozen old steam engine cylinders up in the southeast end of the shop—broken, worn out and replaced by others. Too bad to throw them away, though of no conceivable use, and so they have eaten themselves up—their value as scrap—while cumbering the shop. And so with other things.

Not the least objectionable things with which to cumber up a shop are small tools that have been legitimately worn out in service or broken doing duty. Who under the heavens will ever make any use of that tap, broken off leaving just two threads with the shank. Yet there it is in the tool room, occupying some of the most valuable space about the shop, and so with disabled reamers, worn out cutters, mills, etc. Possibly the blacksmith can make use of them. If not, there is the junkman, failing which Tim can dig a hole and bury them. In any event get them out of the shop. The machinist who should attempt to make any use of them ought to be discharged.

Another thing likely to be a feature of the shop that is too small, is that it was started with the belted tools scattered around promiscuously; room enough, and what's the use of crowding. More tools are added and things don't come right. To the average proprietor and his foreman who has never been through the mill, the re-arrangement of the tools is a job of terror. I should not say this was not so if I did not know to the contrary by experience. All there is of it is to make plans all complete, mapping out just where every tool is to go, get all the appliances for moving in readiness, then the first slack day that comes put every available man at the job and *move*. It is astonishing how much more room will be found in a shop after a general clearing up and a general re-arrangement of tools, and getting rid of the relics of ancient breakdowns and mistakes. It is scarcely less astonishing what a small job it is to move, outside of the determination to do so.

* * *

ROUGH ON EXPERTS.

A few days ago Judge Bacon declared at the Bloomsbury Court that he never believed in expert evidence. A case came before him in which a decorator claimed £30 for work done. Several expert witnesses were called on both sides, and in the end the Judge said: "My experience of expert witnesses is that they invariably are unreliable and seldom speak the truth. I shall go and examine the work myself." His Honor did so, and when he returned to court he said, severely, "I have made a careful examination of the work. Very often I have to rely on expert evidence when I cannot myself personally see what has been done. In the present case I find that the experts have, or at least tried, to mislead the Court. The work is most improperly done, and I must certainly give judgment to the defendant, with costs."—*The Practical Engineer, London.*

[While the criticism of the Judge regarding expert witnesses is too often true, there is at least reason to doubt the ability of the Judge to decide as to the quality of the work, whether it be decorating or steam engineering.]

* * *

Numerous rumors are afloat concerning bicycles for 1897. General prices seem likely to be lower, and there will probably be few wheels even listed at $100.00. Those that are will presumably have decidedly new features as attractions, but it will take several very effective attractions to pull an extra $25.00 out of a man's pocket.

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WE solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense.

ALL copy must reach us by the 10th of the month preceding publication.

OCTOBER, 1896.

CONTENTS:

THE OTHER SIDE SPEAKS.

As MACHINERY reaches all sorts and conditions of men in the field it represents, we have necessarily received numbers of adverse comments on the money article in the last issue; and as we have given space on another page to extracts from the letters of those who commend our policy, it is but fair that we should also allow those who condemn it to be represented. Mr. W. H. Barrett, of Frisco, Beaver Co., Utah, who is one of these, writes us :

You state that the news colums of MACHINERY are not for sale. But from the Editorial in the September number, one would beleive that on the contrary, the colums of the paper, have been purcased to advocate a question that should have been left to the every day press.

Your paper is manifestly unfair and misstatements are made althrough the gold arguement you should have your contributor attend a kindergarten school of finannces, and also teach him to have respect for the truth.

Modesty prevents us from expressing an opinion as to which writer needs the assistance of a kindergarten, but we do feel it necessary to contradict Mr. Barrett's implication that the editorial columns of this paper have been purchased, although this is a familiar accusation against newspapers whose policy is opposed by some of their readers. MACHINERY supports the cause of sound money because we believe it to be right, and there is no truth whatever in the implication made by our correspondent.

Mr. W. L. Miggett, of Ann Arbor, Mich., among other things says:

The unreliability, if not the direct falsity of your statements are apparent to any one who has studied the question with the view of understanding it, and your hope and only chance to influence votes is to catch those who have not yet looked into the question, and to prejudice their minds so that they cannot see the truth when it is presented to them.

The article we published was composed of quite a number of plain statements accompanied by the figures to prove their correctness, but if these statements are false, surely it would be very simple to furnish some figures which prove their falsity instead of writing voluminous letters made up of assertions like the foregoing. The entire free silver theory is supported by just such assertions, and this fact demonstrates the weakness of their cause. On one point, however, we do agree with our correspondents, viz : that they should not be forced to pay for a paper whose policy they oppose; and although in point of fact the money article in September was entirely in addition to the usual amount of mechanical matter, and no reader suffered by its insertion, we have returned these subscribers the amount represented by the balance of their year and will do the same for any free silver reader who feels that he is not receiving full value from us for his money.

We believe that the majority of men in the free silver ranks (not the politicians) are honest in their opinions; but we also believe that they are mistaken, and we have the same right to express our belief that they have. Politics do not enter into the question at all. The real issue as regards MACHINERY is—shall we stand idly by and see a policy adopted which will involve in ruin the industries of the country and inflict incalculable injury upon every reader of this paper, without striving with all our might to prevent it? No! A thousand times, No!

We sit on no fence while such a question as this is being decided. What we believe to be right, as touching the interests that MACHINERY represents, we shall support with all the strength that has been given to us, and what we believe to be wrong we shall oppose, regardless of whom we antagonize by such opposition. L.

* * *

IS IT CARELESSNESS?

It often happens that little conveniences and safeguards which manufacturers devise and put on their machines are either overlooked or not understood by the users. One instance that has recently come to the surface is where a manufacturer of forming lathes, who makes the handle controlling the chuck so it can be adjusted to any position, to accommodate anyone, as he says, "no matter whether they are right-handed, left-handed, knock-kneed or cross-eyed," and yet they are not tightened on the rod, but left to bang down on the bed whenever it drops from the hand; in fact the makers have been obliged to make them of steel castings to reduce the breakage from this cause. A little thought on the part of the operator would not only save handles, but be more convenient for him as well.

Another instance which comes to mind is where the average fox lathe man fails to use the "in" stop on the chasing bar, or in other words the stop which prevents the chaser from being drawn too far into the work. The average lathe man rarely or never uses this stop, except in chasing left-hand threads; probably because he prefers taking the risk of not being able to lift the chaser out of the work at the right point, to taking the time to adjust the stop.

A good fox lathe hand is very expert at this and rarely has any trouble, but the stop will prevent any work being spoiled, as it holds the bar fast while the follower is raised out of the hob by the angle of the thread, and keeps dancing up and down, but not advancing into the work. On small light work where the speed is high, it is quite a knack to lift the chasing bar at just the right moment, and the use of the stop will prevent accidents.

* * *

LAYING OUT A WORM AND WORM GEAR.

W. L. Cheney.

We must, in order to approach the subject intelligently, first consider the nature of the worm and worm gear. If a worm, Fig. 1, were cut in two in the middle, parallel to its axis, and used to print from, we should get an impression like Fig. 2, and Fig. 3 shows the impression if a rack *of the same pitch as the worm* were used to print from. In other words, and in the language of the drawing room, the *section* of the teeth of a rack, and the *section* of the teeth of a worm, are similar, and practically, the same shaped tool that would cut the threads of the worm, Figs. 1 and 2, would also plane the teeth of the rack, Fig. 3.

FIG. 1 FIG. 2 FIG. 3

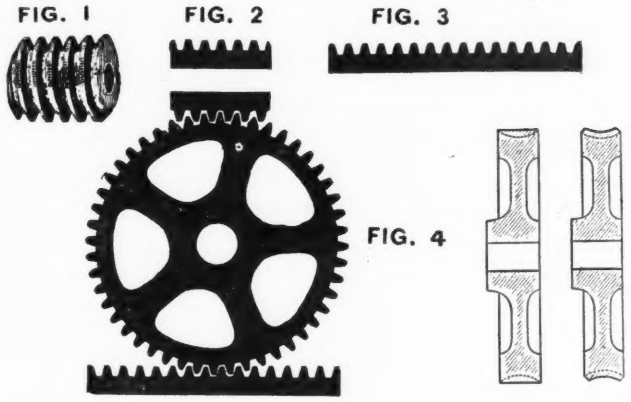


FIG. 4

FIG. 5 FIG. 6 FIG. 7

It is customary in most shops to make the depth of a worm thread and corresponding worm gear tooth, two "diameter pitches" deep (in addition to the clearance, which is usually one-eighth of the diameter pitch; this will be considered later). A diameter pitch is represented as a fraction by 1, divided by the pitch; thus an "8 pitch" gear tooth is twice ⅛ inch deep, exclusive of the clearance. But an "8 pitch" gear has 8 teeth for every inch of *diameter* of its "*pitch line*," whereas a *worm* gear has a certain number of teeth to the inch measuring around the *circumference* of its pitch line, which is an imaginary line half way the depth of the tooth, not considering the clearance. The reason of this is that the worm must be cut in a lathe, a certain number of threads to the inch, and the teeth of the gear must also then evidently be a certain number of teeth to the inch of circumference, in order to match the worm.

As the circumference of a circle is 3.1416 times its diameter, it follows that a gear of "8 pitch" having 8 teeth for every inch of its pitch diameter, would have 8 teeth for every 3.1416 inches of its pitch circumference, and that therefore an "8 pitch" tooth is 3.1416 times as great as a "⅛ inch pitch" tooth, either in a common spur gear or a worm gear.

Beginning at the other end, then, we find that whereas an "8 pitch" gear tooth is twice ⅛ inch deep (beside the clearance), a "⅛ inch pitch" worm gear (or any other gear) is twice ⅛ *divided by 3.1416* inches deep.

It will be noticed that the word "inch" does not appear in mentioning *diametral* pitch gearing, but always appears in mentioning worm gearing or other *circumferential* pitch (or in other words, circular pitch) gearing.

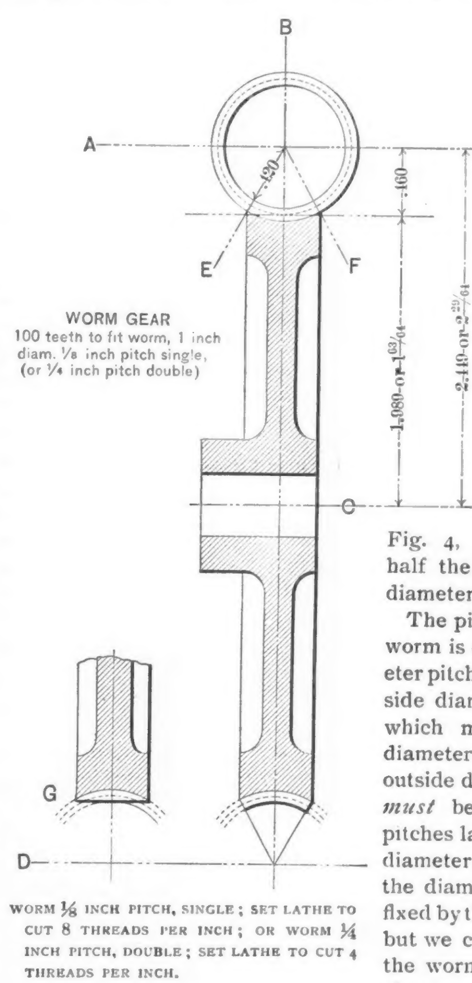
Once understanding the relation that one kind of pitch bears to the other, it is easy to reduce one to the other; for instance, if we wish a worm of 8 threads to the inch and a worm gear running with it which must also evidently be 8 teeth to the inch on its pitch circle, we know that the *pitch* (which is the distance of one tooth from the next tooth) is ⅛ inch, and we know that *a diameter pitch* is ⅛ inch divided by 3.1416, which is .03979, and that the teeth are twice *a diameter pitch* deep, which is twice .03979. A ⅛ inch pitch worm and gear therefore have teeth .079 inch deep, exclusive of clearance.

It will be seen that diametral pitch is very much easier and quicker to figure than circumferential (or circular) pitch. (See note No. 1.)

Referring back to the illustration, if we were to take *either* a common spur gear, or a worm gear, of the same pitch and number of teeth, cut it in two in the center at right angle to its axis, we should get the impression like Fig. 4; if it was a worm gear it would be revolved when the worm Fig. 2 was revolved, one tooth (if a *single* thread worm, two teeth if a double thread worm, etc.) to each revolution of the worm; if it was a spur gear it would be revolved one tooth for each one tooth movement of the rack; the *worm*, then, is an *endless circular rack*; the rack Fig. 5 is a duplicate of the rack Fig. 3.

Figs. 6 and 7 show two forms of worm gear. Fig. 6 could, after being turned, be cut for either a spur or worm gear of equal pitch and number of teeth, but it is customary in most shops to make the form shown in Fig. 7, which is hollowed out to fit the worm; the only reason for doing this is that our grandfathers did it, except that some people think the form Fig. 7 is better looking; but as Fig. 7 has no practical advantage, my preference is Fig. 6.

As a gear has a certain number of teeth for every inch of its pitch diameter, it follows that the center distance, whether of two spur gears or of a worm and gear, is half the sum of the two pitch diameters; this is evident from looking at Figs. 2 and 4; the pitch line of the worm being half way down the tooth, must evidently exactly meet the pitch line of the gear Fig. 4, which is also half way down its tooth (not considering clearance). The distance from the center of the worm Fig. 2 to the center of the gear Fig. 4 is therefore half the pitch diameter of the worm added to half the pitch diameter of the gear Fig. 4, or in other words half the sum of the pitch diameters, as first stated.



WORM ⅛ INCH PITCH, SINGLE; SET LATHE TO CUT 8 THREADS PER INCH; OR WORM ¼ INCH PITCH, DOUBLE; SET LATHE TO CUT 4 THREADS PER INCH.

The pitch diameter of the worm is evidently two diameter pitches *less* than the outside diameter of the worm, which may be made any diameter we choose, but the outside diameter of the gear *must* be two diameter pitches larger than the pitch diameter; in other words, the diameter of the *gear* is fixed by the number of teeth, but we can evidently make the worm any diameter we choose, same as we could make the *width* of the rack anything we choose.

We can also make the width of a worm gear anything we choose, but a good practical width is one half of the outside diameter of the worm and there is nothing gained by making it any wider, whereas making it narrower would reduce its wearing surface; but practically any designing that brings enough pressure on the teeth of a worm gear so that it will wear out sooner

than the rest of the machine, is bad designing, even if not as wide as half the diameter of the worm.

When all this is understood, we may proceed to "lay out" the worm and gear as follows:

Assume a worm of one inch outside diameter, running with a worm gear of 100 teeth; pitch, $\frac{1}{8}$ inch. Draw center lines A and B; at the point of their intersection as a center, draw a 1 inch diameter circle representing the outside diameter of the worm; then with the dividers set one diameter pitch less, draw a circle representing the pitch line, and another with the dividers set two diameter pitches less, representing the bottom of the threads of worm. Referring to the figures given above we find a diameter pitch to be .03979 and two diameter pitches to be .079. The nearest we can practically set the dividers is .04 and .08 ($\frac{4}{100}$ and $\frac{8}{100}$), which can easily be done on a common scale divided into hundredths of one inch, or if no such scale is handy, it is near enough for *drawing* to go to the nearest sixty-fourth, which may be found on almost any scale; the nearest sixty-fourth in this case would be two and one-half sixty-fourths and five sixty-fourths.

The gear of 100 teeth will be one hundred diameter pitches, which is 100 times .03979, or 3.979 diameter on its pitch line; the center of the gear will therefore be one half of 3.979, or 1.989 from the pitch line of the worm, and the nearest sixty-fourth to this is $1\frac{63}{64}$, at which distance we draw the center line C of the gear, and by drawing another center line D at the same distance from C as the original center line A, we get the center from which to draw the arcs representing the teeth and pitch line at the opposite side from the worm, and lines drawn from both centers at 60 degrees, will also give the shape of the gear if it is wanted to follow the conventional form, or drawn as shown at G will give the form shown in Fig. 6. Lines drawn at 60 degrees from the center also give a width of gear that is one half the outside diameter of worm, at their intersection with the circle representing the outside diameter. (See lines E and F.)

The following table will save much labor in calculations in connection with laying out worms and worm gears. This table was calculated by Francis H. Easby, superintendent of the Detrick & Harvey Machine Co., Baltimore, Md., except that I have added the "nearest 64th" column for drawing purposes, and left out some other columns not necessary for drawing purposes:

Pitch of Single Worm.	Depth of Tooth.	Nearest 64th.	A Diameter Pitch.
$1\frac{1}{2}$ inch.	.955	$\frac{61}{64}$	.47746
1 "	.63662	$\frac{41}{64}$	.31831
$\frac{3}{4}$ "	.4773	$\frac{31}{64}$	.23874
$\frac{2}{3}$ "	.424	$\frac{27}{64}$	.21227
$\frac{1}{2}$ "	.318	$\frac{5}{16}$	.15915
$\frac{1}{3}$ "	.212	$\frac{7}{32}$	.10610
$\frac{1}{4}$ "	.159	$\frac{5}{32}$	.07958
$\frac{1}{5}$ "	.127	$\frac{1}{8}$	.06366
$\frac{1}{6}$ "	.106	$\frac{7}{64}$	.05305
$\frac{1}{7}$ "	.0909	$\frac{3}{32}$	.04547
$\frac{1}{8}$ "	.079	$\frac{5}{64}$	.03979
$\frac{1}{9}$ "	.0707	$\frac{5}{64}$	.03535
$\frac{1}{10}$ "	.06366	$\frac{1}{16}$	.03183
$\frac{1}{11}$ "	.0578	$\frac{1}{16}$	.02893

"Pitch of Single Worm" must not be confounded with the *number of threads per inch* with which the worm is cut. A single threaded worm (or any screw, for a worm is only a screw with a certain shape of thread) of 8 threads per inch is evidently $\frac{1}{8}$ inch pitch; 4 threads per inch, $\frac{1}{4}$ inch pitch, etc.; that is, 1 divided by the number of threads per inch gives the pitch of *a single threaded screw or worm.*

The pitch of a *screw* is the distance moved in one turn, so that a $\frac{1}{4}$ inch pitch *double* threaded worm would have the same size of threads as a $\frac{1}{8}$ inch pitch single, and a worm gear of 100 *teeth* to fit a worm of $\frac{1}{4}$ inch pitch double thread would be *drawn* exactly the same as the worm gear of 100 teeth of $\frac{1}{8}$ inch pitch single.

A drawing for a worm and gear should be marked both the pitch and the number of threads per inch of worm, because if the number of threads per inch is not marked on the drawing, the man who runs the lathe must figure it out for himself *every time the job is done.* It is easy enough to reduce "$\frac{1}{8}$ inch pitch" to "8 threads per inch" mentally, but a little more confusing when the pitch is like the first three in the table. Of course any lathe man ought to be able to know how to cut "$1\frac{1}{2}$ inch pitch," or "$\frac{3}{4}$ inch pitch," or "$\frac{2}{3}$ inch pitch" screws, but any calculating *after the drawing is done,* is *waste labor,* and these things should be done once for all, when the drawing is made.

1. divided by the pitch of screw gives the number of threads per inch, thus:

1 divided by $1\frac{1}{2} = \frac{2}{3}$ threads per inch.
1 " " $1 = 1$ " " "
1 " " $\frac{3}{4} = 1\frac{1}{3}$ " " "
1 " " $\frac{2}{3} = 1\frac{1}{2}$ " " "
1 " " $\frac{1}{2} = 2$ " " "
1 " " $\frac{1}{3} = 3$ " " "

and so on.

When everything so far is understood, we can shorten the labor of calculating and laying out the worm and gear thus:

When the depth of the teeth is two diameter pitches (see note No. 2), the *outside* diameter of any gear is evidently the same as the *pitch* diameter of a gear *with two more teeth.* We can therefore ignore the pitch line in drawing the worm and gear, and the operation would be as follows:

Set dividers to draw the 1 inch circle representing outside diameter of worm; then set dividers $\frac{5}{64}$ less (the "nearest 64th" of the table) and draw the circle representing bottom of thread of worm, then:

Outside diameter of gear = same as *pitch* diameter of gear with 102 teeth; therefore outside diameter = $102 \times .03979$ = 4.05858, and center line C half of 4.05858 = 2.029 ($2\frac{1}{32}$ = nearest 64th) from *bottom of thread* of worm, which makes the distance from center of worm to center of gear $2\frac{6}{64}$ as before.

We can now take one final plunge and reduce the work of calculation to almost nothing by using the following table from Grant's Handbook on the Teeth of Gears:

PITCH DIAMETERS FOR ONE INCH CIRCULAR PITCH.

FOR ANY OTHER PITCH, MULTIPLY BY THAT PITCH.

Teeth.	Pitch Diameter	Teeth.	Pitch Diameter	Teeth.	Pitch Diameter	Teeth.	Pitch Diameter
10	3.18	33	10.50	56	17.83	79	25.15
11	3.50	34	10.82	57	18.15	80	25.47
12	3.82	35	11.14	58	18.47	81	25.79
13	4.14	36	11.46	59	18.78	82	26.10
14	4.46	37	11.78	60	19.10	83	26.43
15	4.78	38	12.10	61	19.42	84	26.74
16	5.09	39	12.42	62	19.74	85	27.06
17	5.40	40	12.74	63	20.06	86	27.38
18	5.73	41	13.05	64	20.38	87	27.70
19	6.05	42	13.37	65	20.69	88	28.02
20	6.37	43	13.69	66	21.02	89	28.34
21	6.69	44	14.00	67	21.33	90	28.65
22	7.00	45	14.33	68	21.65	91	28.97
23	7.32	46	14.65	69	21.97	92	29.29
24	7.64	47	14.96	70	22.29	93	29.60
25	7.96	48	15.28	71	22.60	94	29.93
26	8.28	49	15.60	72	22.92	95	30.25
27	8.60	50	15.92	73	23.24	96	30.56
28	8.90	51	16.24	74	23.56	97	30.88
29	9.23	52	16.56	75	23.88	98	31.20
30	9.55	53	16.87	76	24.20	99	31.52
31	9.87	54	17.19	77	24.52	100	31.84
32	10.19	55	17.52	78	24.83		

Having drawn the circles representing the outside diameter and bottom of the thread of worm, we can now locate the center line C very easily, thus (mentally): *½ of 102* teeth=51 teeth; diameter of 51 teeth (from table)=16.24, which, multiplied by the pitch $\frac{1}{8}$, = 2.03 = $2\frac{1}{32}$ (nearest 64th) as before.

With the understanding that double, triple, quadruple, etc., worm threads are the same *sizes* every way as $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, etc., of the same *pitch* of *single* worm threads, it should now be easy to "lay out" any worm and gear.

Regarding clearance, it is customary to make the clearance at top and bottom of teeth equal to $\frac{1}{8}$ of a diameter pitch, but this is a matter of opinion. Clearance is described by Grant in his Handbook on the Teeth of Gears as follows:

"Theoretically, the depression formed inside the pitch line should be only as deep as the projection outside of it, is high; but to allow for practical defects in the making or in the adjustment of the teeth, and to provide a place for dirt to lodge, the depression is always deeper than theory requires by an amount called the clearance."

Some shops make clearance on worms and worm gears, same as on spur gears; other shops think clearance is not necessary on worms and worm gears, and make them accordingly; but which ever way made, the laying out on paper (drawing) is the same.

NOTE No. 1.—I have long advocated that all worms and gears should be made diametral pitch, which could easily be done by adding two special gears to the set of change gears of any lathe. Those interested can find a paper on the subject in the transactions of the American Society of Mechanical Engineers, Vol. 10, page 333, of the year 1887.

NOTE No. 2.—Some shops prefer to use other depths than two diameter pitches. If any other depth is used, the outside diameter is evidently not the same as the pitch diameter of a gear with two more teeth, and consequently this shorter method cannot be used, it being necessary to work from the pitch lines as first described.

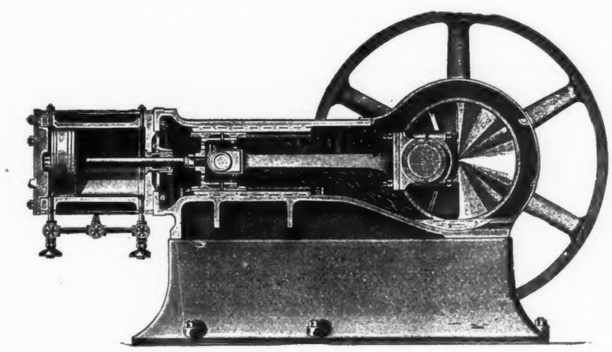
FRICTION LOSSES AND OILING SYSTEMS FOR STEAM ENGINES.

E. T. Adams.

Next to the loss due to initial condensation, friction causes the greatest loss of power that occurs in the steam engine. Ten per cent. of the rated horse power is perhaps its average value, the percentage being greater for small engines than for those of larger size. To give it a cash value we may take $50.00 a year as the value of a horse power when developed by an engine of moderate size; then with an engine of 150 rated horse power, $750.00 a year is the value of the horse power wasted by friction.

Friction loss is usually stated as a "per cent." of the rated power. Repeated experiments* have shown that it is practically constant for a given engine running at constant speed. Therefore as the actual average load falls below the rated load, the work of friction becomes constantly greater in proportion to the useful work. Or if the engine rated at 150 HP. develops an average of but 75 HP., the value of the useful work and the lost work of friction are respectively $3 000.00 and $750.00. With larger engines a saving of even 1 per cent. of this lost work often amounts to a considerable sum, and it seems strange that the matter has not received more attention from the commercial world.

Friction may be reduced in three ways—by careful designing, by good construction, and by the use of lubricants. The better class of engines are now so carefully designed and constructed, that there cannot be great differences in internal friction due to these two causes alone, and the hope for a reduction of friction lies between roller bearings and improved methods of lubrication. As to the latter, a new system has lately been devised which brings into renewed prominence two other successful systems of the same general type that have preceded it.

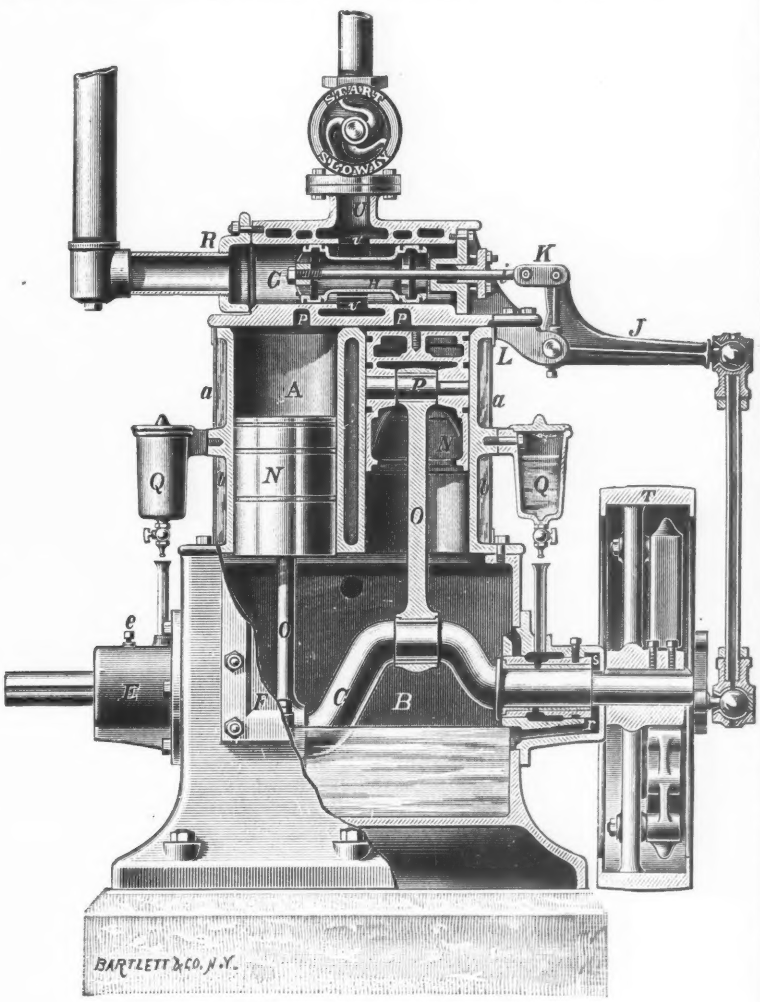


IDEAL ENGINE.

The system in most general use is the oil-cup system, whose crowning glory is the sight-feed oil-cup, but the very certainty with which this oil-cup can be relied on to deliver regularly a drop of oil is its worst feature when considered as a part in a system of oiling which is intended to reduce friction. All theory aside, I think that almost universally in practice the engineer "saves oil" by feeding as few drops as possible; he expects the bearing "to warm up some," but a careful engineer sees to it that it does not get "too hot." In other words the controlling idea is not to reduce friction to the lowest possible limit, but rather to feed as little oil as possible without allowing dangerously high temperatures in the bearings. It usually seems to escape attention that the rise in temperature is a direct measure of the work of friction, and that in these days of very generous proportions for all wearing surfaces, the high temperature exists notwithstanding a very large radiating surface, where even a small increase in temperature means a considerable increase in the loss by friction.

Dr. Thurston's experiments just referred to, showed conclusively that the friction of a bearing could, and in practice did, vary between two extremes, the one where the friction varied by laws approximating the laws for solid friction, while at the other extreme, where the bearing was flooded with oil, the variation followed quite closely the laws of fluid friction.

The bearings cannot be flooded with oil, unless the engine has been designed with this in view, without making a terrible mess in the engine room. Not only the engineer, but the manufacturer as well, has assumed that oil was to be "saved" by feeding as little as possible to each bearing; accordingly there is usually no provision, or at best entirely inadequate provision for arresting the drip thrown out by the engine, and after the engine is erected, the owner, under his engineer's direction, installs such oil shields and pans to catch the drip as circumstances seem to demand. These accessories seem fairly efficient when but little oil is supplied to the bearings, but are utterly useless where enough oil is supplied to secure an approach to fluid friction. In the May number of the *Engineering Magazine*, in a thoroughly instructive and enjoyable article by W. H. Wakeman, we find the following statement: "High speed means more friction, and that means a larger expenditure of oil," seeming to imply a greater waste of oil, a statement that is generally true, but it is not necessarily so. It is true because the greater part of the oil is commonly wasted after it has once passed through the bearings; wasted because the builder of the engine did not make adequate provision for saving it. Probably there is no writer on subjects connected with steam engineering who has more intimate knowledge than Mr. Wakeman of the fact that oil is not worn out by use, in the sense that bearings or clothes are worn out, but is lost partly by being allowed to drop from the bearings and leak away, partly in the process of filtering and some by evaporation. The loss by drip and leakage is inexcusable. The loss in filtering will increase with increased friction, as this means more wear



WESTINGHOUSE "JUNIOR."

on the bearings and an added quantity of impurities that must be removed from the oil. The loss by evaporation depends on the oil and the temperature.

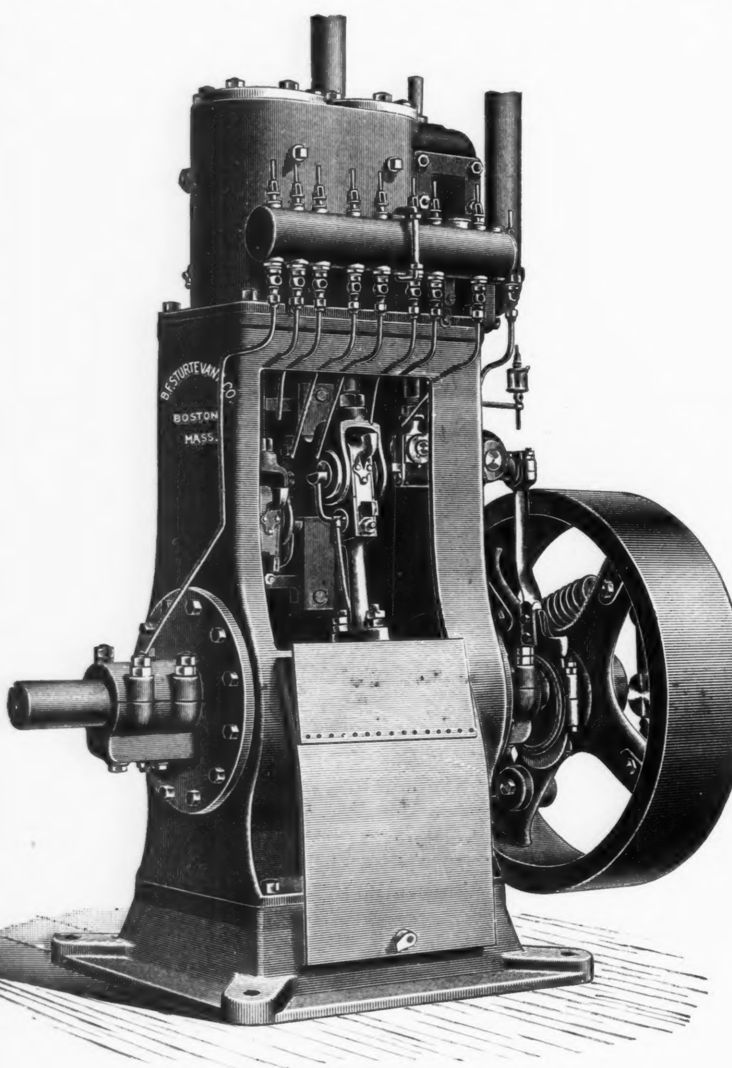
An enclosed crank case will prevent leakage. An increase in the quantity of oil passed through the bearings will reduce friction, and consequently the loss in filtering, and we may assume that the loss by evaporation is the same. It is safe, then, to say that the enclosed crank case with flooded bearings will take less oil than is needed for the oil-cup system, and the reduction in friction and the infrequency of repairs and renewals is all clear gain. It will often be true that with this system less attendance will be required. It insures cleanliness in the engine room, and it seems certain to the writer, that in a very short time it will be the only system considered admissible, at least for high speed work.

The enclosed crank case is the outward and visible sign of a consistent application of the well known bath system of lubrica-

* Friction and Lost Work, Thurston, Wiley & Sons.

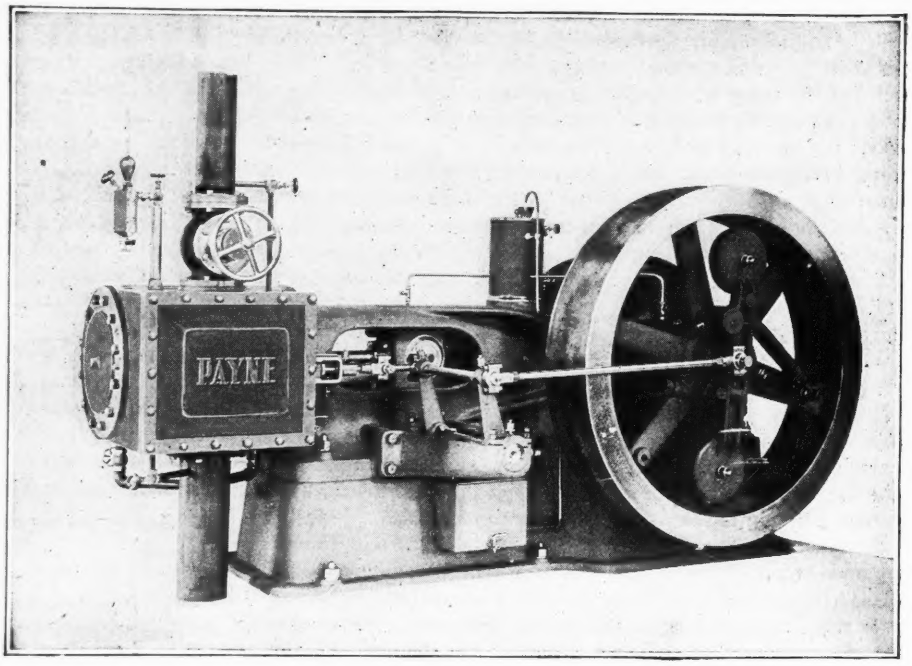
tion. The Westinghouse and Ideal engines are pioneers in this field, and the results secured both in the reduction of friction and their ability to stand hard usage and continuous running, speak eloquently for oil and plenty of it. Both of these engines are so well known it is hardly necessary to describe the methods adopted by either, but in passing we may note that in each the reciprocating parts are enclosed in a crank case which is partly filled with oil or oil and water, which, as the engine turns, is splashed not in drops, but in great waves over every part of the interior, grooves and oil-holes admit the oil to every bearing, and in the Ideal engine these channels conveying the oil are so placed that the engineer can see the oil flowing in a great stream to each of the main bearings.

The Westinghouse Company report tests on new engines of moderate size showing internal friction of 5 per cent. and lower, and there seems to be no reason to doubt but that any well designed and constructed engine using this system of lubrication will exhibit equally good results. Now 5 per cent. internal friction instead of 10 per cent., which is usually considered a good figure, means a saving, even on the small engine we have been considering, of about $1.50 for each working day in the year. There are hundreds of small plants in this country with three or four engines of 75 to 200 HP. each where the daily preventable loss by friction would go a long way toward paying for the cost of attendance.



STURTEVANT ENGINE.

B. W. Payne & Sons are new comers in this field, with some good points of their own This company originally used the oil-



B. W. PAYNE & SONS HIGH SPEED ENGINE.

cup system, but when they changed, the design of the frame was altered somewhat, and like the Westinghouse and the Ideal, the enclosing case is designed as an integral part of the frame and does not have the appearance of an afterthought, tacked on to cover up some deficiency. No oil is carried in the crank case, hence it is possible to make the frame open at the side, and the engineer can get at the wrist-pin to tell whether it is running cool, a small door in front of the sheet steel guard over the crank-discs allows access to the crank for the same purpose.

The oil starts from a tank placed on the top of the frame. Pipes lead to each bearing, where the oil pours into a conical shaped cup, giving a sight-feed at every bearing. After passing through the bearings the oil runs to the bottom of the frame and drains out to a receiving tank in the sub-base; here it passes through a filter and the clean oil is forced up to the tank again by a simple plunger pump, driven by a small eccentric on the rocker shaft. In the Payne, as in the Westinghouse and Ideal engines, very effective methods are employed to supply plenty of oil to both the crank and wrist-pin. The details are hardly in place here; it is only necessary to say they are simple and effective.

The details of these three engines are of course different, and each will doubtless be able to prove that his system is the best; but from our standpoint they are alike in marking a distinct advance over the older and more general practice.

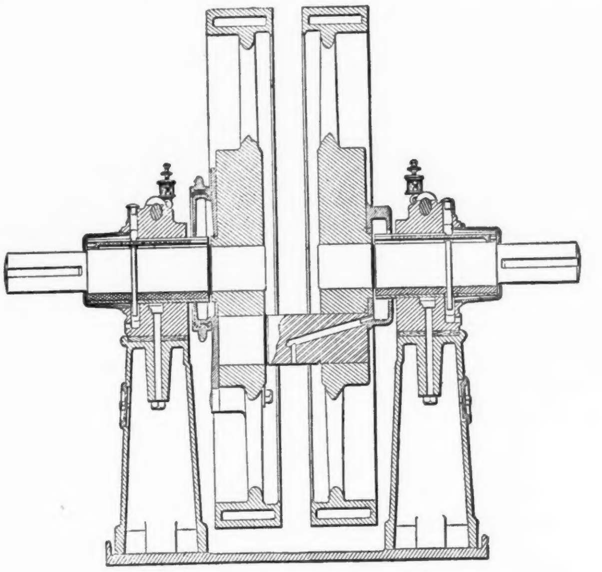
I do not wish to be understood as saying that these three engines are the only ones that can show low internal friction. Any engine fitted with the bath system of lubrication will do that if it is well built and of good design, and the Straight Line should be mentioned as another engine with low friction, a result secured by a most original combination of good design, careful and accurate construction and provision for continuous oiling.

The loss by internal friction is but a small part of the total loss between the coal pile and the fly-wheel; but small as it seems in comparison with these greater losses, it is large and often seriously large compared with the power delivered, and is unique among the losses in a steam plant since it costs nothing to eliminate a very large percentage of it. The water evaporated per pound of coal will increase as the cost of the boiler and its accessories are increased. The power delivered per pound of steam supplied to the engine will increase with an increased cost of engine. But the loss by friction can often be cut in half by simply specifying a bath system of lubrication when buying an engine. It will cost no more than the oil-cup system, and any builder can provide it and will do so if buyers demand it.

The engines mentioned are all high-speed engines, and it is to this class that the writer especially refers; but there is no reason why, with any type of engine, the friction of these parts should not

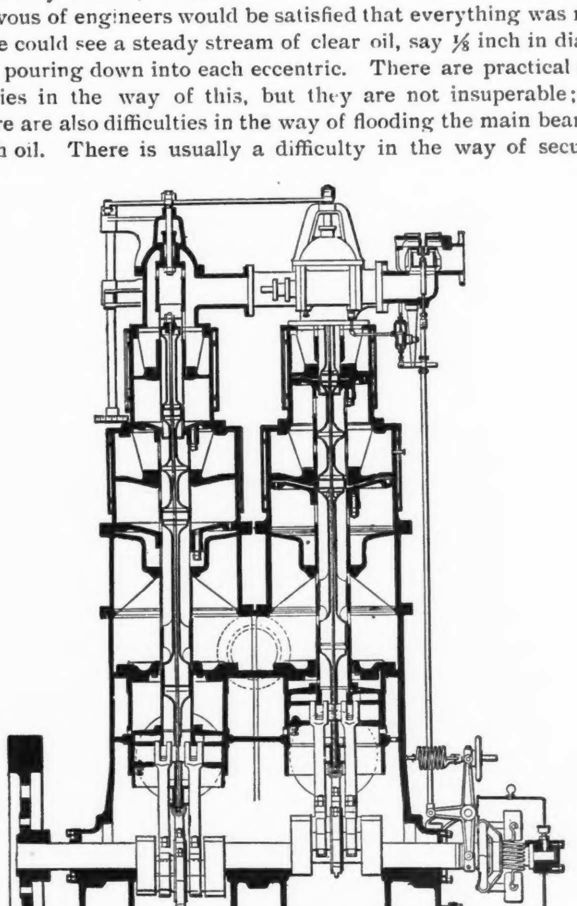
be reduced to half or quarter of its present value simply by supplying plenty of oil.

Take for example a Corliss engine with two eccentrics; throw of each eccentric 5 inches; diameter of shaft 12 inches; revolutions per minute, 100—rather high speed, but this is the modern tendency. A careful engineer will watch those two eccentrics very closely. Any hour in the day he can tell you instantly which one you will find the hotter and just how hot it is. It is argued that he would look with disfavor on any housing or box that would enclose these sufficiently to allow efficient lubrication.



CRANK-PIN OILING DEVICE, STRAIGHT LINE ENGINE.

This may be true, but it seems to the writer that even the most nervous of engineers would be satisfied that everything was right if he could see a steady stream of clear oil, say ⅛ inch in diameter, pouring down into each eccentric. There are practical difficulties in the way of this, but they are not insuperable; and there are also difficulties in the way of flooding the main bearings with oil. There is usually a difficulty in the way of securing



WILLANS ENGINE, BUILT BY THE M. C. BULLOCK CO., CHICAGO, ILL.

anything good, and in this as in other cases the reward is to him who overcomes it.

[In this connection it is interesting to note that the subject of thorough lubrication has had the attention of some of the best mechanics of our time. As far back as 1867 Prof. John E. Sweet, who has given us so much that is useful in engineering, used the "oil ring" running loosely on the shaft and dipping into the oil well, which is now so common. These were also used in the second Straight Line engine ever built (which was shown at the Centennial), and have been used in every one since then. The crank-pin oiling device used by Prof. Sweet is also of interest and is shown in the other column.

The Willans engine is also of the type having its bearings flooded with oil, as will be seen in the cross section, which is reproduced from the *American Machinist*. These are not all the engines with continuous lubrication, but the more prominent ones which could be secured for this article. The new Ball-American engine is said to have some excellent devices, which we shall probably show later.

About thirty years ago Mr. J. W. Thompson used a centrifugal device for oiling the crank pin. This was modified into the well known device of a tube connected to the crank-pin with a hollow ball at the other end, the ball being in line with the center of the main shaft. This was oiled by placing the spout of a can in the hollow ball, centrifugal force attending to the rest of the operation. It has been further improved by the use of a sight-feed oil-cup placed on a stand so as to feed continuously into the ball while it is revolving. These devices were all worked out by Mr. Thompson, of the Buckeye Engine Co.

Mr. Chas. T. Porter, in the early Porter-Allen engines, took oil with a wiper which caught a drop near the journal as the crank came around and threw it out by centrifugal force through holes to the crank. Mr. Porter also adopted a fixed cup and wiper to oil the cross-head end of the connecting-rod.—ED.]

* * *

THE CORROSIVE ACTION OF PURE WATERS.

It is not generally known that pure, soft water will corrode boilers, and so may be undesirable to use. It would seem that the purer the water and the more free, consequently, it is from scale-making matter and from salt, soluble magnesia compounds, and other substances known to cause corrosion, the better it would be for boiler purposes, and up to a certain point this is true; but it has been found by experience (and experiment shows the same thing), that waters carrying a certain small proportion of solid matter, and perhaps making a little scale, are better for boiler use than those that would be extolled as the finest drinking waters.

Pure water itself has very little solvent power for iron, and a fixed amount soon takes up all the iron it can hold. Indeed, on bright surfaces pure water exerts hardly any action at all; and yet there are cases in which a bad corrosive action can occur from apparently pure water, as, for example, when condensed water is delivered back to a boiler so near the shell as not to first mingle freely with the water in the boiler. The feed, in this particular case, will not only dissolve away all scale near the point of discharge, but will also eventually badly corrode the boiler itself.

Even trap rocks and granite yield some soda and potash to water, so that the tendency of the organic matter and decomposable saline constituents to acid decomposition is continually corrected; and in our best waters, from pure sources carrying some organic matter, a varnish-like coating, consisting of compounds of low iron oxides with organic matter, soon covers the iron surfaces, and protects them very perfectly, sometimes for many years.

New boilers, new tubes, and new work generally, that has not acquired this protective coating, are apt to suffer when first put into survice with a very soft, pure water, such as follows the melting of the snow in the spring, or the copious fall rains which fill our streams and reservoirs; and the singular phenomenon is sometimes presented, of new tubes or new boilers giving out, so that they had to be replaced even more than once, while old ones, worked under the same conditions, remain serviceable.

The corrosive power of pure water on new or unscaled boilers was well illustrated in the city of Glasgow, when a new water supply was introduced from Lake Katrine, one of the purest waters in the world which is available for city consumption. (The facts are given in Rowan's little handbook on "Boiler Incrustation and Corrosion). The former supply had been poor and calcareous, and old boilers were much coated with lime scale. To the dismay of the users, those who had put in new boilers or new tubes found them rapidly corroding, while the old scaled and coated boilers remained as before; and those who had removed every possible trace of old incrustation from their old

boilers, by mechanical or chemical means, "in order to get the full benefit of the pure water," were also badly troubled by corrosion; and even the old boilers, as the scale was gradually removed by the unvaryingly soft, pure water from the lake, were more or less corroded when no means were taken to prevent it. It was found, in this case, that introducing a little lime from time to time—enough to give the boilers a slight calcareous coating—usually prevented the corrosive action of the water, and in the course of time the lime, organic matter, and iron oxide skin formed a protecting, oxidized surface that prevented further corrosion.

It will be inferred, from what has been said, that the most perfect boiler water is one which makes a slight deposit in the dryer seasons, and has this deposit largely dissolved off by the soft water of spring and fall, so that the balance of efficient working, without much scale and without serious corrosion, is practically kept. Fortunately, many of our Eastern boiler waters fulfil these conditions. It will not do, however, to rely entirely upon nature to keep the balance, in even the best boiler waters; for the condition of the water will vary from season to season, and even the smallest amount of solid matter, whether soluble or not, will accumulate, in time, to a dangerous extent, if not blown or cleaned out.—*The Locomotive.*

* * *

MACHINISTS' PIECE WORK.

M. S. Link.

Under this heading, in the April edition, was an article which attracted my attention. The author seems in great trouble in consequence of his inability to procure "good machinists." Undoubtedly there is to-day a smaller percentage of men who have the ability and skill which identify first class machinists than there were a few years ago, for two if not more reasons.

First. There is an increasing demand for a higher grade of work.

Watt, in a letter to one of his friends, boasted that he had an engine of such accurate workmanship that a half-crown piece could not be passed between the piston and cylinder. This was good work in *his* day, but to-day we find quite a different state of affairs. A first class machinist of to-day must be able to keep within one ten-thousandth of an inch of stated sizes. Not saying, however, that this is an every-day requirement with every first class man, but when he *is* given a piece of work which does require measurement within that limit he must be able to accomplish it. A few years ago many who were considered as first class would have laughed at the idea of measuring to so fine a point as absurd.

Second. There is to-day less chance for the young man mechanically inclined to obtain a general knowledge and practice in the machine line. Not many years ago nine out of ten machine shops were doing general work, while to-day there are but three or four out of the same number. An apprentice taken into the jobbing or contracting shop sees or works on something new each day, and if he is a "born mechanic" he takes a personal interest in his work, always elated when he receives a piece of work to do which will further try his ability and skill. To be sure, when his three or four years of apprenticeship have expired he is seldom an expert at any one thing, but he has a general knowledge which enables him to handle any ordinary work—perhaps a little timidly at first—after he leaves his apprenticeship. You can scarcely show this young man a piece of work that will not remind him of some job he did while "serving his time," and he will recall how he accomplished it, and proceeds accordingly unless the foreman gives him special instructions in regard to it.

He knows *one* way of doing it at least, and that is the principal thing, for no one could say he didn't know how to do it even if he was not posted on what the foreman considered the most approved method.

How about the youth who enters the specialty shop? His changes of work are few and far between in comparison with those of the jobbing shop apprentice, and he must be eternally "kicking" for change of work or he gets no show at all, for the specialty manufacturer is quite reluctant to change his boys from work which they have become thoroughly familiar to something which they require instructions on and are awkward with at the start. And as for a boy becoming a thorough mechanic in a piece-work shop, it is simply impossible. He possibly gets two or three shifts until he finds a job to which he appears adapted, and there he rests. He has no confidence in his ability to get or hold a job elsewhere, for he knows he will find work with which he has had no experience; so he throws what energy he has into the work he has, in a vain struggle to make a mechanic's wages out of it. He turns automatic feeding apparatus to the machine of which he has become a part; and from time to time as this automatic feeder speeds up, his wages are cut proportionately. Perhaps he is a little conceited and has some courage; then perhaps he will quit his piece-work and walk boldly into the jobbing shop and recommend himself as a machinist. You now have one of those men who carry the honorary title of "monkey wrench machinist," and what I consider the greater source of their production.

Machine builders are crying out for better mechanics, yet they show a steady tendency to do the very things which are extinguishing the all-around man. There are always opportunities for all around men to drift into piece-work jobs; but seldom, if ever, does the man who begins his mechanical life in a piece-work shop succeed as an all-around man. Hence many who have the natural talent to become good mechanics are lost in the piece-work shop, and many who have acquired a thorough training in the jobbing shop find it profitable to enter the piece-work shops and compete with the less skilled men found therein. And again, since there are fewer first-class men, we will not find them looking for jobs in bridge works or plow shops. They are after the cream of what there is to be had, and they get it. You will find them making the tools, jigs, etc., to enable the "monkey-wrench mechanics" to turn out two pieces alike.

A clean, comfortable place to work in, with gentlemanly treatment, are becoming attractions of no small importance to first-class men. Another reason for there being so much semi-mechanical ability afloat, is the negligence of employers who work their men by the day or hour, to pay them according to their value. How often we see two men working side by side, when the work of one is of half the value of that of the other; yet they draw the same rate of wages, and the better man of the two finds it impossible to get an increase in his pay. This being the case, what is there to stimulate ambition?

Perhaps this man, on account of his superior ability, determines to try piece-work, secures a job and makes a good thing until it is noticed in the office that there is a man in the shop who draws from twenty-four to twenty-eight dollars per week; the reducing process is commenced, and at the end of a year or two this man finds himself doing twice the work for as little or less money than he received before at day work, gets disgusted, quits and goes back to a day-work job, where he can at least take pride in turning out nice work and advance himself mechanically, although he receives no encouragement to turn out more than the slowest man in the shop.

The author of "Machinists' Piece Work," in making his comparison to Paderewski, seems to think a steady job the only thing to be sought by a mechanic. Now I *sometimes* take wages into consideration, and I believe most all other mechanics do. I consider the Paderewski comparison as deficient for this reason: Paderewski, with but a comparatively slight degree of skill above his nearest competitor, receives a salary of probably twice as much; but how about the machinist who, by the piece-work system, is finally lodged in the place for which he is adapted? Does he receive any other reward for the extra value he is rendering his employer? I have noticed that they are generally worse off in the end, for he is shut out from general work. His mechanical talent and ability is practically standing still.

So much for the scarcity of good machinists; now about day-work and piece-work. Neither are giving perfect satisfaction. Why? Simply from a lack of honesty. Either would be perfect in the hands of honest, careful managers and honest employees. Let the man who manages his shop on the day-work plan show a disposition to pay labor according to its value. Let him pay a few of his best men from thirty to thirty-five cents per hour and reduce his drones according to their sleepiness, and then you will see every man in the place, from the most ignorant laborer to the mechanics of the highest skill, striving to climb a notch higher. Thus he will cause a healthy competition among his men for his money, not unlike the competition he meets in the market with his goods, competing with others for the buyers' money. Not so with the shop whose foreman says: "We don't pay higher than two-fifty for machinists and one-fifty for laborers." In a shop of this kind, when a man gets the highest wages to which he is entitled, according to the fixed rules of the shop, he

simply pokes along, doing the least he possibly can and still holds his place.

It is the same with piece-work. If the proprietors would be satisfied with three-fourths of the extra profit caused by piece-work and give the other fourth to the producers, all would be well; but the trouble is that no matter how hard a man works or how much profit the proprietor makes on him, the proprietor cannot bear the thought of that man making above so much per day.

The author of "Machinists' Piece Work" concludes thus: "Piece-work is the only thing which will pay men according to their ability." I contend that while piece-work will tend to place each man in his highest productive capacity, it will place him there at a rate no higher than day-work would bring him, if he is a thorough mechanic capable of doing general work.

OBITUARY.

J. F. HOLLOWAY.

The many warm friends of the late J. F. Holloway learned with grief of his death on September 4th, at Cuyahoga Falls, Ohio. Born in 1825, his life was devoted to mechanics in various forms, and he was known to nearly everyone in mechanical engineering circles. He served the American Society of Mechanical Engineers in various capacities, being president in 1884 and 1885, and was one of the most active workers in the Society, his ability, genial manner and quiet humor winning him hosts of friends. Mr. Holloway's most recent connections were with Henry R. Worthington, and for the last two or three years with the Snow Steam Pump Co., of Buffalo, N. Y., as consulting engineer.

EVERY DAY SHOP SUBJECTS.—1.

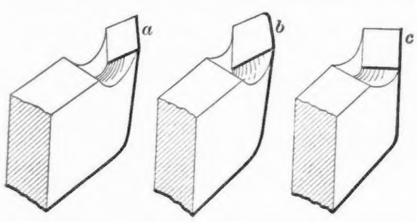
CHIPS.

Little chunks of wisdom,
Little leaks to mend,
Make the output larger
And increase the dividend.

Believing that much can be done to increase the output of many shops, by means of some of the handy kinks in use in other shops, the writer will endeavor to present a few of the many points in shop practice which has come up in his own experience. The ideas and devices may not all be new or novel, and possibly some may consider them defective, but as these columns will probably be open to any one who can show up the imperfections, no harm will be done; and if I suceeed in calling out other and better devices, they will not be altogether useless. Questions or criticism addressed to the editor will be forwarded to me and I will try to answer them satisfactorily.

LATHE TOOLS.

One of the things which usually bother apprentices, and some older men too, is the question of lathe and planer tools (for they are very closely related), as each man usually has some peculiar shaped tool, with a "leettle more or less rake" than the other fellow, depending largely upon the shop in which he was brought up. Probably the well known "diamond point" is the most used of any, owing to traditions I presume, for on a great majority of work I have long thrown by the precedent and used only the diamond point when I could use nothing else. This is usually when there is a long slender piece of work in the lathe, which must be humored so it won't spring and climb up on top of the tool, which usually puts it in close resemblance to the corkscrew family. In this case I know of no single tool which will do as well as the diamond point, as its fine cutting point, while it lasts, has less tendency to spring than other forms. This is shown in the left hand sketch of the three tools, Fig. 1.

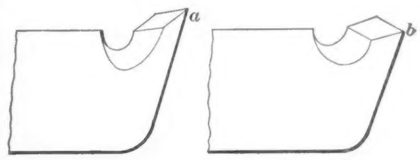


While the tempering has much to do with the point standing the racket of severe cuts, I have never seen any tool that would not stand better for rounding the point, even if only with an oil stone (but not so as to destroy the rake), and when rounded, as in the middle tool, at *b*, they stand much better and leave the work much smoother than the sharp point. This leaves a marked thread, more or less regular according to the slip of the feed belt, and a sharp V of the angle to which the tool happens to be ground. The thread left by the round point tool is much less objectionable as the work is much easier to finish, or at least takes much less allowance for a finish, and by finish, I don't mean filing by a long ways.

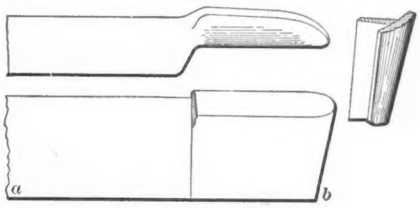
There may be cases where a file finish is not objectionable, but they are like the proverbial hen's teeth—scarce—and are only permissible where an exact uniform size is not necessary and a polished finish only is desired. It is practically impossible to file a piece of work *round* or even as near round as the lathe leaves it —and as for a uniform size, it is also practically impossible, to say nothing of the extra time taken, for no hand work can produce a uniformly cylindrical surface as rapidly as a machine, either lathe or grinder.

The careless lathe man will not take proper care in grinding his tools and the points are ground down, leaving the heel high and changing the cutting edge of the tool into a gouging or tearing edge, breaking up the chip badly and requiring more power to pull the lathe. Tool *c*, in Fig. 1, shows this to a slight degree. This can happen with any kind of tool, but the diamond point seems to offer the greatest inducement for this, it is so easy to grind just a little on the point. On the other hand, some men waste time in tool grinding by being over careful and then spending several minutes in oilstoning it to death.

Fig. 2 gives an idea of the right and wrong ways of grinding a diamond point tool, or any of its relatives; the side view showing the rake at *a* and the lack of rake at *b* very clearly. A tool ground as at *a* will cut cleanly, give a clean chip and take comparatively little power, while *b* will tear the work and leave an unsatisfactory finish. The kind of chip does not amount to so much of itself, but it tells the kind of a tool that has been used. This, of course, refers only to wrought iron or steel and not to cast iron or brass.

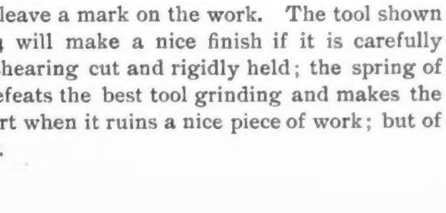


For rough work and, in fact, nearly all work except the finishing cut, I have come to use the tool shown in Fig. 3, which is known by the delicate name of "hog nose" or "bull nose" in many shops. It is a cross between a side tool and a round nose, and will do more work with less grinding and take less power than any tool I know of, for all except finishing cuts. The cutting edge can be 45 degrees from the vertical for most work, but the clearance between the cutting side and the work should be as small as can be run, 5 degrees will answer usually, as the cutting edge wants to be as well supported as possible; this is a point to be remembered in all work.

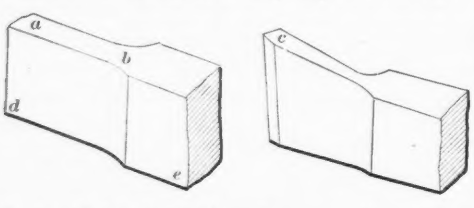


These tools can be ground on either the top or end, and they should be set so as to have the cutting edge come about in the center line of the work; that is, the cutting edge should be about radial from the center of the work. A little experimenting in this line, mixed with common sense, will be of more value to the apprentice than any thing that can be written. These tools are becoming more common and are used by some of the largest shops in the country, and the metal they can peel off in a moderate sized lathe would make Mr. Podunk's man Jack groan louder than ever.

When it comes to finishing work, the diamond point is all right if you don't use the point, but use the side as shown in Fig. 4, and it's quite a little trick to set the tool so as to take a smooth finishing cut. The side next to the work should be flat, with possibly the corners relieved, so as not to leave a mark on the work. The tool shown at the right of Fig. 4 will make a nice finish if it is carefully ground with a good shearing cut and rigidly held; the spring of the tool post often defeats the best tool grinding and makes the machinist sick at heart when it ruins a nice piece of work; but of this we will talk later.



Cutting off tools are usually a source of annoyance to the young machinist and a good many not so young, and the advent of good cutting-off machines have relieved the latheman of much disagreeable work as well as saving money for the proprietor. There isn't much to be said about cutting-off tools that isn't known already, but there are one or two points that are too often overlooked. Everyone gives a cutting-off tool side clearance, or at least tries to, which for the benefit of that new boy who has just donned the overalls and jumper, I may say is making the cutting point *a* wider than the neck *b*, so as to avoid binding as the tool goes into the cut. The engraver has given the cutting edge a wave of his own; it should be straight and square, if not square it will tend to crowd to one side. In the right hand view is shown what may be called a "second" off tool, only being intended for use after the square tool has cut to nearly the required depth. The V point, *c*, should, however, be in the center of the tool and the bevel evenly divided. The use of this tool makes a V groove at the bottom of the cut, allows the piece to be easily broken and also insures its breaking in the center of the cut, preventing the break running into either piece, as is almost sure to be the case when only the square tool is used. Cutting-off tools of either type are helped by having considerable top rake as shown in the right hand tool, as it makes a cleaner cut into the piece.



The main point I wished to make is in having the tool supported clear to its end, or as far under the cutting edge as possible, for this adds to the capacity for rapid work and avoids much of the annoyance of the work climbing on to the tool. It will be seen in both cases that the bottom of the tools are made perfectly straight (as from *d* to *e*) and level, and this allows them to be supported more than is possible, or at least practical in the ordinary tool post. Where no attention is paid to this and the tool bears in the tool post no nearer the point than *e*, as is often found, the tool cannot be as steady in the work or nearly as satisfactory.

* * *

SELECTING BOILERS FOR MILLS AND FACTORIES.—2.

W. H. WAKEMAN.

The first that I refer to is a case where two tests were conducted at different times with the same engineer in charge, on the same boilers and using the same coal. While consuming 6.3 pounds of combustible per hour for each square foot of grate surface, 12.6 pounds of water from and at 212 degrees were evaporated, but when the rate of combustion was increased to 13.7 pounds per square foot per hour, the rate of evaporation fell to 11.8 pounds of water. Even the higher rate of combustion cannot be called excessive by a conservative engineer, and yet with one half this rate the efficiency is higher. Here are no different conditions to be taken into consideration, for everything except the rate of combustion is the same. Another test made with the same type of boilers, but by another engineer, using a different grade of coal, shows that while burning 20 pounds of coal per square foot of grate surface per hour, he secured an evaporation of 12.4 pounds of water. Another test made by still another engineer with the same type of boilers using a different grade of coal, shows that while burning 27.5 pounds of coal per hour, he evaporated but 10.9 pounds of water. This rate is too high for either comfort or economy. Passing on to still another test with same type of boilers, made by another engineer, we find that he consumed 40 pounds of combustible and evaporated 9.9 pounds of water on the same basis. This is excessive, and any man who would recommend it, or try to carry it on for any length of time, should be considered a first-class crank to say the least. In this case the boilers were run at more than 100 per cent. above their rated capacity. During the second test mentioned they were run at more than 50 per cent. above their rating, while in the case showing the greatest economy they were run at about 55 per cent. of their capacity. These figures speak for themselves and are worthy of consideration.

Taking the case of two horizontal tubular boilers, with practically the same ratio of heating to grate surface, burning 9.4 pounds of coal per square foot of grate, an evaporation of 10.39 pounds of water was secured, but when the rate of combustion was increased more than 50 per cent., using the same grade of coal, the evaporation was increased to 11.1 pounds per hour. It will be noted that this rate is not excessive. Two tests made on the same boiler but with different kinds of coal, show that while burning 6.7 pounds per hour 11.24 pounds of water were evaporated, but with a rate increased to 11.9 pounds the evaporation was reduced to 10.6 pounds. A well known expert in this line of work, reports two tests made for the express purpose of determining the difference between the rates of combustion of 6.5 and 12.1 pounds per hour, reports 1 per cent. in favor of the slow rate, and points out what changes might cause the result to be in favor of the more rapid rate. This shows that within reasonable limits, a varying rate may not effect the result materially.

Taking all things into consideration, I do not believe that a rate above from 12 to 15 pounds of coal per square foot of grate surface per hour is to be recommended, assuming that the ratio of heating to grate surface is a proper one which may be taken at about 40 to 1 for anthracite coal and about 60 to 1 for bituminous, except in the case of vertical boilers, where it is sometimes made less than this with good results. While it is true that the horse power of boilers depends on the amount of water evaporated, still this will in turn depend on the location and the amount of heating surface provided. Some kinds of heating surface are much more efficient than others, therefore we cannot establish an arbitrary number of square feet for all kinds, but under average conditions and with a moderate fire, a tubular boiler will develop a horse power for each 15 square feet of heating surface, a flue boiler with 10, a plain cylinder with 8, and a water tube with 12. One of the best water tube boilers now in the market, showing excellent results when used under reasonable conditions, was forced until it was developing a horse power for each 6 square feet of heating surface, but its efficiency was very much reduced on this account.

When considering the durability of boilers under the different rates, I would remark that a boiler will last long enough to evaporate a certain amount of water, and if it is forced to dispose of this amount (whatever it may be) in a short time, then its life will be short; but if used at a reasonable rate its life will be lengthened accordingly. Just which plan will suit the owner best, remains for him to decide. It is natural for men to try and use a boiler plant just as long as possible, and this often means an extension of time beyond the safe limit; therefore I would recommend that measures be adopted to postpone the evil day as long as possible. If a wagon of any kind is used longer than it ought to be and breaks down under a heavy load, the loss of a portion of a day's time is usually the extent of the damage, but if boilers are used longer than their condition warrants, they are not only ruined, but surrounding property is destroyed and often many lives are sacrificed.

If two boilers are made exactly alike and one of them is forced to its utmost capacity, while the other is used at a moderate rate, the repair bills will be much greater for the former than for the latter.

When we come to consider the ability to make long continuous runs, the boilers that are allowed a good margin will have the advantage, for if a poor grade of coal is unexpectedly encountered, sufficient warning may be given to prevent a shut down, but otherwise the plant may be brought to a standstill. Temporary inattention on the part of firemen will have a much more disastrous result in one case than in the other, and although these things should never happen, still they always have in the past and always will in the future, therefore it is well to prepare for them.

Having decided on the total power of boilers needed, it is well to consider the size of the units of power, or in other words, whether we shall use large boilers and few of them, or small ones and more of them in our mill or factory. One boiler of 300 horse power capacity can be run with less fuel than 3 boilers of 100 horse power each, provided they are all of the same type in order to make a just comparison, although the difference will be small. On the other hand, if one large boiler is installed, and while in operation one tube gives out, the whole plant must be shut down until repairs can be made, and this might cost more than the large boiler could save on fuel in a year's time, while with 3 smaller boilers it is quite possible to cut out one, if any part of it is disabled, and run with the other two for a few days. This should be an important consideration in electric light or electric railway

plants, where a shut down will not be tolerated. One large boiler will occupy less room than three small ones, and the economy of floor space is constantly made prominent in engineering matters, but while it should be a consideration, it ought to be carefully weighed in the balance and taken for what it is worth and no more. The single unit will cost less than the three units, but first cost is disposed of once for all at the beginning of the life of the plant, while a cheap and poorly designed boiler plant will be a constant source of annoyance and expense.

When we come to consider the type of boiler to be adopted we find a great variety to select from. The use of high pressures to run compound and triple expansion engines, and the somewhat numerous failures of tubular boilers, have brought the water tube boiler in various forms into great prominence, principally because it is claimed to be non-explosive. Where a boiler is so constructed that the water is contained in small compartments, this claim is a just one, but if it consists of a shell of good size filled half full or more with water while in service, I am of the opinion that the addition of a bank of water tubes to the bottom of it will not save the shell from disastrous explosion. If as much time and money is spent on a tubular boiler as in building a water tube boiler, the former would be practically safe from explosion, if as well cared for as the water tube is. Return tubular boilers can be made to safely carry 250 pounds pressure, which is about as high as even the most modern engine calls for.

I know where there is a piece of a so-called safety boiler, the explosion of which caused the destruction of $5,000 worth of property. Are not these facts enough to cause us to pause before we hastily decide that there is but one type of boiler that is safe from explosion and capable of carrying high pressures? If a tubular boiler is set up on end, and a fire built under the lower head, is it any more safe than if it were placed horizontally and a fire built under a part of the shell? The vertical boiler has one advantage along this line, for it can be constructed with a thicker shell than the ordinary tubular boiler, because with the former the fire does not come into contact with the shell, and this is an advantage, for if the shell were made an inch thick in the latter the water would not protect it from the fire, especially where the joints bring a double thickness of plate into the case. The following formula may be used to determine the strength of the shell of a tubular boiler: $\frac{(T\,S)\,J\,P}{R\,F}$ = safe working pressure. In which (T S) = tensile strength, J = strength of joint, P = thickness of plate, R = radius of boiler and F = factor of safety. Good boiler material possesses a tensile strength of 60 000 pounds, the best joints possess more than 90 per cent. of the strength of the solid plate, which we assume to be one-half inch thick, the radius may be 24 inches and the factor of safety is sometimes taken as low as 4. Applying this we have $\frac{60\,000 \times .90 \times .5}{24 \times 4} = 281$ pounds, or if we wish to have a boiler 60 inches in diameter, the safe working pressure would be 225 pounds under the same conditions, and if we make the value of F 5 the working pressure will still be 180 pounds.

It is claimed by some that on account of the water tube boiler being made of such thin material it takes up the heat more readily, which is true, but it also loses it readily for the same reason. In a certain factory they have a tubular boiler and a water tube boiler side by side. One week they use one and the next week they use the other, and report no difference in the amount of fuel required. I give this report for what it is worth and no more, realizing that it is a very crude test, but when we consider that the tubular boiler holds the heat over night much better than the other, we can see how the advantage of thin material readily absorbing heat, or rather conducting heat, is offset in the tubular boiler.

Some of the water tube boilers (for their name is legion), show great ability to dispose of water, but this water is not all evaporated, as much of it is simply thrown out with the steam, hence their great apparent efficiency. I believe that the greatest per cent. of moisture found in any test that I have heard of, is that reported by an intimate acquaintance, where he found it to be as high as 62 per cent. This, of course, is an exceptional case, but sometimes the reported performances of safety boilers border on the miraculous, hence it is well to call for a full report of manner of conducting the test, that it may be known how the results were obtained.

DON'T WAIT—SEND NOW.

From hundreds of letters, principally from workingmen, and referring to the sound money article in September MACHINERY, we make a dozen extracts which fairly represent the prevailing sentiment on this question in the machinery trade:

Will do immense good as a pocket companion for all classes as well as workingmen. A. G. CURTIN, JR., *672 Bullitt Building, Philadelphia.*

The best article we have yet read on the money question.
A. W. CADMAN MFG. CO., *Pittsburgh, Pa.*
John F. Robertson, Sec. and Treas.

I enclose ten cents for a hundred copies of your anti-rotten money article. Thank GOD you have taken it up.
F. W. BRADY, *204 Greene St., N. Y. City.*

Thanks for the sensible stand taken.
J. SCHULTZBACH, *713 Sixth St., N. W., Washington, D. C.*

The most forcible short article on the silver question that I have seen. E. A. JOHNSON, *29 Linden Place, Hartford, Conn.*

In the best possible shape for the class of people who need such an article most. Am glad to see MACHINERY is a paper with sand enough to say what is right, regardless of policy.
H. B. MAXWELL, *Rome, N. Y.*

The best and most comprehensive article I have seen.
E. W. BUSS, *14 North Canal St., Chicago, Ill.*

Wishing you success in the noble stand you have taken for what I believe to be a just and righteous cause. THOS. BRAY, *Mattoon, Ill.*

The plainest and best piece of sound money literature I have seen.
C. WESTEHOFF, *Glenfield, Pa.*

The stand you have taken on the silver question is timely, and I hope other trade papers will follow, and thereby put a stop to this senseless, but ruinous political agitation. J. H. DUNBAR, *Youngstown, O.*

You should be congratulated for the fearlessness you have manifested in placing, through the columns of your paper, the absolute truth of this great question before workingmen.
C. S. LINCH, *1507 Tioga St., Philadelphia.*

The strongest and best campaign document I have seen. It has been in my possession but two days and has already won over two silverites.
J. P. SLOAN, *343 Manhattan Ave., Brooklyn, N. Y.*

We send these leaflets free on receipt of postage—two cents for twenty-five; ten cents for one hundred. If you believe in an honest dollar, if you value the honor of the nation, if you want a return of prosperity, don't sit around and croak, but put your shoulder to the wheel and PUSH; and one good way to push is to help us distribute these leaflets where they will make votes. Don't wait to send for them some other day; send *now.*

* * *

BREAKING UP CASTINGS.

The illustration shown herewith is not a guillotine, and the man immediately below the drop is not a victim—at least not of the instrument shown. This was an improvised drop-hammer for breaking up castings, and was found hard at work near the shops of Prentice Bros. and the Powell Planer Company in Worcester, Mass. The weight was hauled up by a rope attached to a dilapidated cart dragged by a horse which would answer the same description. A trip, operated by the man below, through the medium of a rope, served to release the weight to do its work. There are probably other places where a similar rig would save time and labor in demolishing old castings.

* * *

THE *University Scientific Magazine*, of Knoxville, Tenn., for August, has several pages devoted to freehand lettering, taken from the drawing room practice of various well known firms. These are very interesting and useful to any draftsman.

* * *

One of the causes of failure with the operation of a good many machines is the assumption that no brains are required to run them. There isn't a machine made that is so automatic or simple that a little horse sense won't help things along considerably.

ENGINEERING PROBLEMS.

HIGGINSON BOILER SETTING—A COMPACT POWER PLANT.

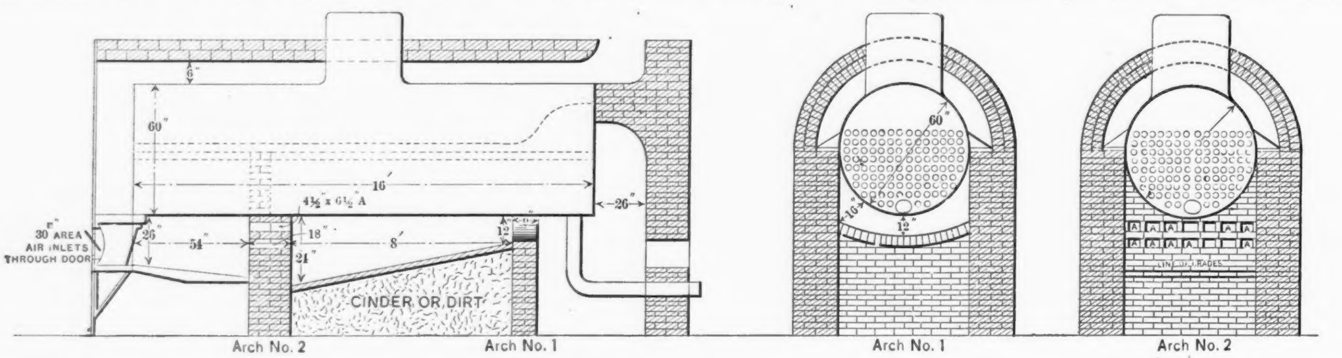
The accompanying plans have been sent us by Wm. O. Webber, 78 Mason Building, Boston, Mass., being from his recent practice. The Higginson boiler setting needs little explanation, the heat from the furnace going through the opening in arch No. 2, the combustion chamber, over arch No. 1, returning through flues and back again over top of boiler to stack. Mr. Webber says regarding it:

"DEAR SIR: I send you under separate cover BP. of the Higginson boiler setting, and can state that I know from actual tests that the device is not only a complete smoke consumer, but also every foot of space had been utilized. Those who have to plan for engines, boilers and their appliances in cramped quarters can probably obtain points from this which will be of value to them.

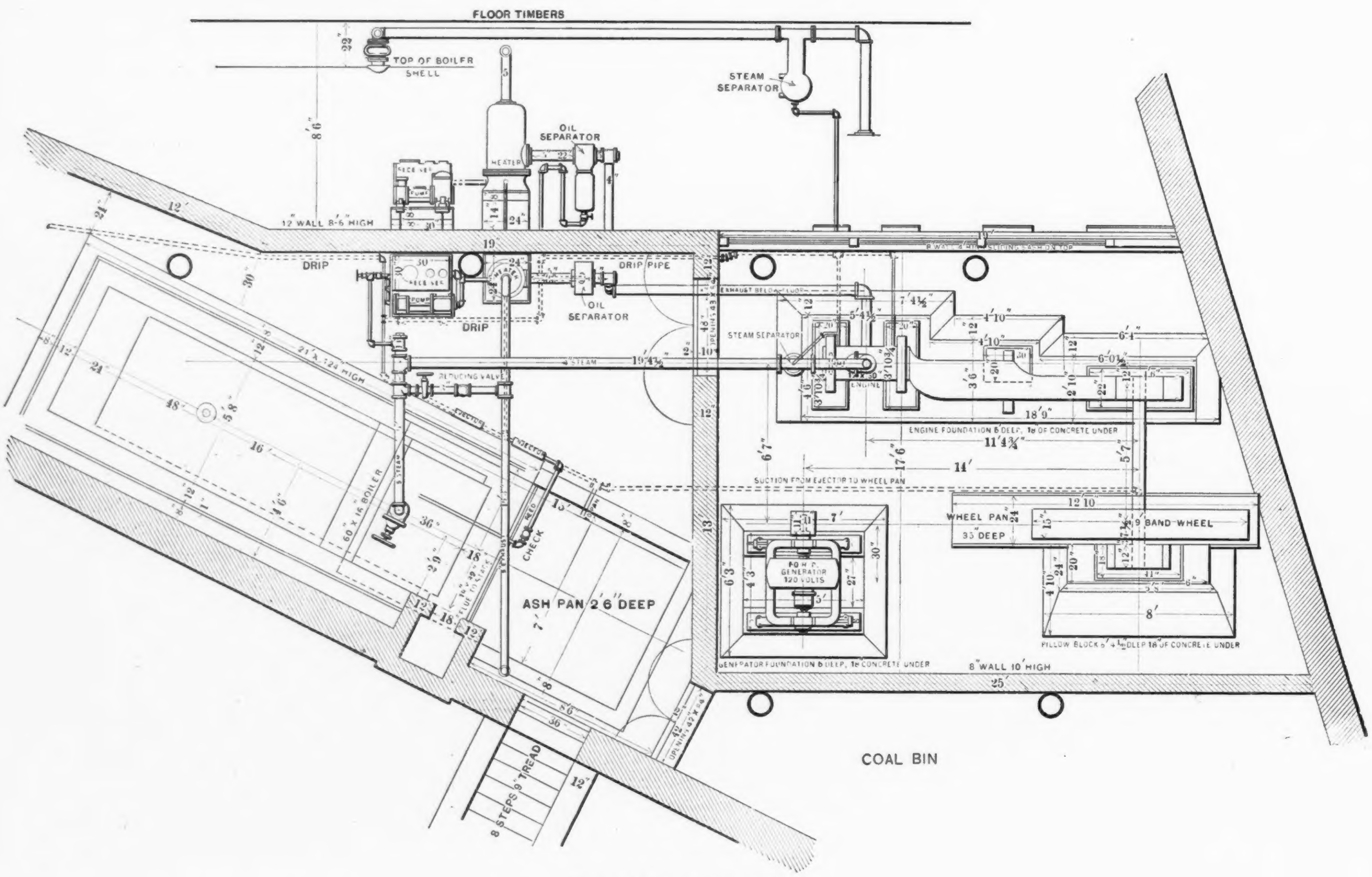
* * *

ALLOYS.

In his fourth lecture on alloys, delivered at the Mason College, Birmingham, Mr. McMellan showed by means of tables and curves, that the results of adding increasing quantities of one metal to another were variable. Thus, in brass, the addition of zinc to pure copper at first caused a somewhat irregular rise in the strength of the copper, until 20 per cent of zinc had been



HIGGINSON BOILER SETTING.



PLAN OF BOILER PLANT.

shows a saving of from 15 to 20 per cent. in the amount of fuel used on Western coals and 10 to 15 per cent. on Western coals with boilers set in first class manner. I have already put in several of these appliances in this city and they are working in a very satisfactory manner. "Very truly yours,

"WM. O. WEBBER."

COMPACT POWER PLANT.

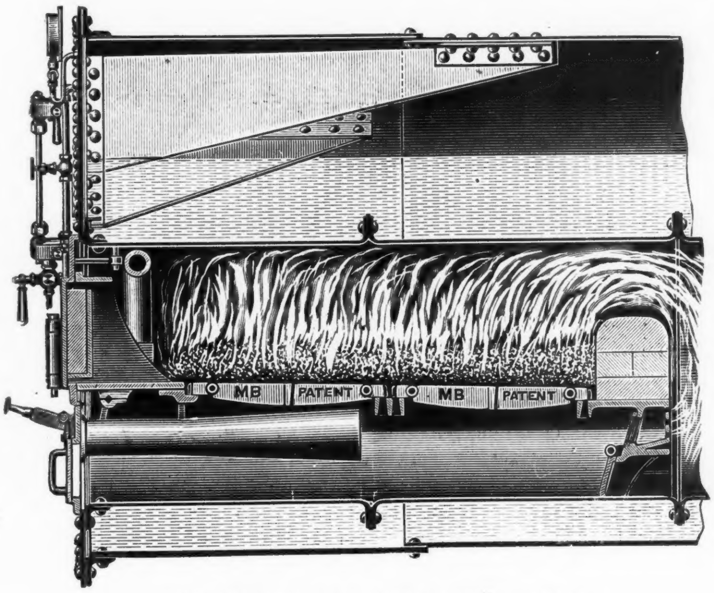
This is a plan of the steam plant put into John C. Hayne's building, 307-9 Atlantic Avenue, Boston. Mass. The upper portion is an elevation of the receiver, heater, separators, etc., as will be seen by careful observation. This is about as complete and compact a plant as one often sees, and it seems as though practically

introduced; then there was a slight falling off until the alloy of 30 zinc and 70 copper was reached. This was followed by a rapid increase in strength and the maximum was obtained with the mixture 42 of zinc and 58 of copper, and after this the continued addition of zinc led to a sudden and strikingly marked decrease in strength, in toughness, and in ductility, the minimum strength occuring with the alloys containing from 69 to 70 per cent of zinc, which were intensely hard and brittle. Bronze gave a somewhat similar curve, but the maximum strength was reached after the addition of 18 per cent. and the minimum strength after 32 per cent. of tin. Similar curves were shown for gold and aluminium, nickel and iron, and other alloys.—*Practical Engineer, London.*

AN ENGLISH SYSTEM OF FORCED DRAFT.

James Vose.

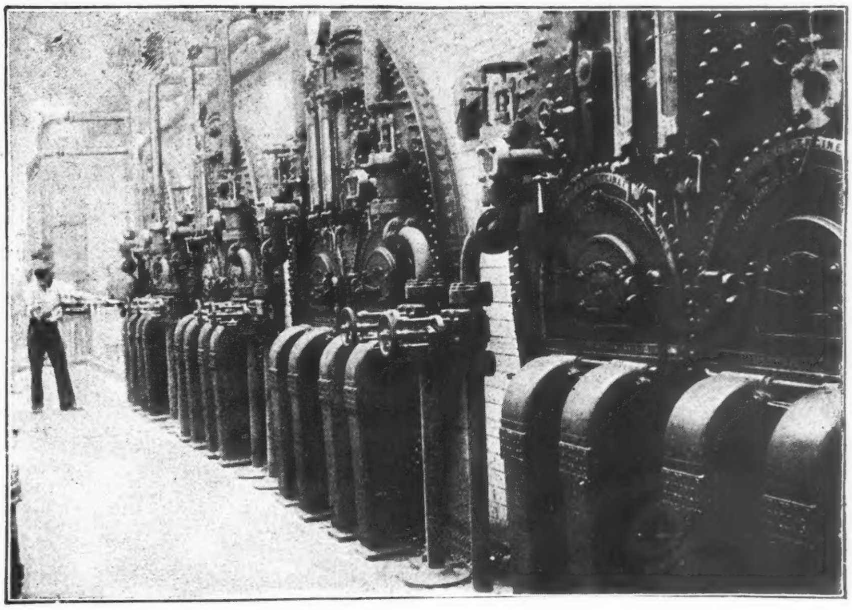
The utilization of what were formerly considered "waste fuels" has of late years become a matter of every-day practice in the British Isles, and is also attracting much attention in other countries. The "Meldrum" dust fuel and forced draft furnace is one of the most prominent and largely adopted systems, and some account of it may be of interest to readers of this paper. This furnace is quite as useful in the matter of obtaining exceptionally



SECTIONAL VIEW OF "MELDRUM" FURNACE.

high duty from boilers using good fuel, as it is in enabling steam boilers, brewing coppers, puddling, reheating, and other forms of furnaces to be fired at an extremely low cost, as fuels now used were often a source of considerable expense simply for their removal. Previous to the introduction of the "Meldrum" system, more or less successful forms of waste fuel furnaces were temporarily used, the means adopted for obtaining the forced draft being either noisy and wasteful steam jet blowers crudely connected to the boiler furnaces, or fans blowing air into a closed ash-pit, the fire-bars being immersed a part of their depth in a trough of water to prevent their burning. The first form of furnace used too great a proportion of the steam generated in the boiler for working the blowers, besides being unsightly and extremely noisy; and the second type was of comparatively large first cost, trouble often arose from breakdowns of the engines, fans, etc., just when steam was most needed, and the boiler was made difficult of access for inspection or repairs. Even with these drawbacks the burning of small inferior fuels was found to be distinctly profitable. In designing the "Meldrum" furnace, some of the conditions sought to be fulfilled were, absence of moving parts, compactness of all parts of the apparatus, so that nothing should project further from the boiler front than the fitting generally found on hand-fired boilers, easy removal of fine ashes from the ash-pit, long life of fire-bars, easy clinkering, easy adjustment of blast, and the method of firing to approximate as closely as possible to ordinary hand firing by ordinary firemen. As about 4 000 of this type of furnace have been fitted, up to date, it would appear that these conditions have been well met by the apparatus. As will be seen by the engraving, illustrating a Cornish boiler fitted with the system, the draft is produced by a fine jet of steam (either from the boiler itself or from any convenient steam pipe) blowing concentrically into specially shaped blowers or pipes which lie in the ash-pit underneath the fire-bars, the blowers being secured to a closely fitted iron plate (which closes up the ash-pit) by gun metal heads acting as nuts, each head at the same time carrying a nozzle which is fed with steam from a port-hole running through a central arm in the head. Two heads are used in each furnace, coupled by a connecting pipe. The blower and head being screwed, provide a simple method of setting the nozzle concentric with the bore of the blower (which is an important point). A self-sealing door on the ash-pit plate affords facilities for clearing the ash-pit of fine dust which falls through the fire-bars. The proportions of the blowers are the result of long, careful and expensive experiments, and the blowers are the simplest and most efficient at present known, the weight of steam used being only 2 to 3 per cent. of the steam raised in the boiler, and the spaces between the fire-bars being only full $\frac{1}{16}$-inch, it is calculated that the amount of fuel saved by this means is sufficient to provide the steam used by the blowers. The steam jets answer also the purpose of cooling the fire-bars, and it is found that clinkering is an easy matter even with the dirtiest fuel, as the clinker will not adhere to the bars, but is easily drawn out in the form of flat cakes.

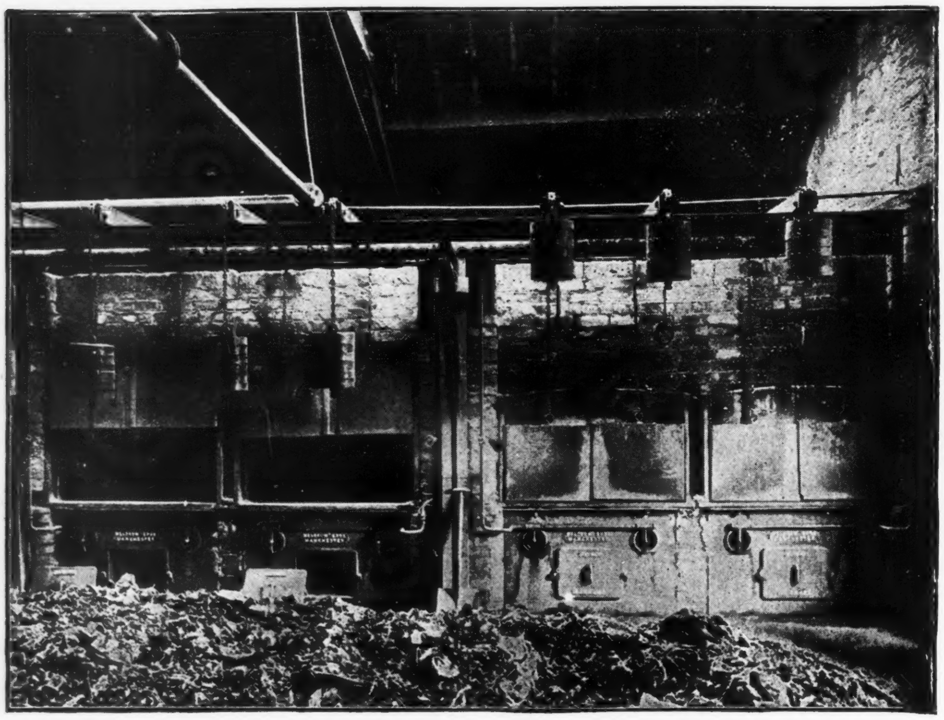
It may here be remarked that as the blast can be regulated to a nicety by a valve or cock, no cold air need be drawn into the furnace, as the pressure of air can be so regulated as to balance the chimney draft. As the accidental lifting of a single fire-bar when cleaning out will often cause it to burn and quickly infect the whole grate, a simple peg and socket interlocking arrangement is provided, which obviates trouble from this source (see illustration). Practically every known form of boiler has been successfully fitted with this type of furnace, and two specially useful applications are in connection with electric lighting and the disposal of town's refuse. As land on which city electric light stations are built is often extremely valuable, it is found very advantageous to be able to work boilers at low rates of combustion during the lightly loaded hours, and to instantly obtain an extremely high rate of combustion during the time of the heavy load, or in case of a fog suddenly appearing. The number of boilers (and consequently the space occupied) can thus be kept at a minimum. It may here be remarked that most London stations employ both water tube and Lancashire boilers, each having its own peculiar advantages under certain conditions. Electrical engineers in England are well situated as regards choice of boilers, as the highest class of internally fired (Lancashire or Cornish type) or water tube boilers are easily obtainable (see illustration of Lancashire boilers fitted with "quietners" on the blowers, at Islington electric light station, London).



ISLINGTON ELECTRIC LIGHT STATION, LONDON.

In small towns it is often found practicable to burn the towns refuse in ordinary boilers used for steam raising in connection with municipal undertakings, thus saving the cost of fuel and rendering much easier the disposal of refuse. An illustration is here given of a very successful installation for this purpose at Rochdale. The makers are also patentees of special boilers and destructors for carrying out refuse destruction on a large scale

where such is desirable. To facilitate smoke prevention, a valve dead-plate is provided by means of which an extra quantity of air can be supplied above the fire just after the green coal has been thrown into the furnace. After a short time (the exact duration of which varies under different conditions) the valve door in the dead plate is closed and the pressure of air is again mostly under the fire-bars. Of course, where anthracite coal is used, no provision for smoke prevention is necessary, but this furnace forms a most convenient means of burning anthracite coal where the chimney draft is not of itself sufficiently keen. Great use is made of this system in South Wales for burning very fine screening of anthracite, of which there are almost mountains in some colliery districts, but which are now being utilized for steam raising in the colliery boilers, thus leaving a larger supply of ordinary sized coal for disposal. To obviate the possibility of any water of condensation which might be carried into the blower steam feed, causing corrosion in the flues of internally fired boilers (especially in the case of boilers working at a very low steam pressure) a superheater is used. This consists of a curved pipe placed over the crown arch of the dead-plate; the pipe is thus exposed to the heat of the fire and the feed steam passes into it from the boiler at one end and out to the blower jets at the other. The steam is thus kept fully up to its initial pressure and has just sufficient moisture in it to keep the fire-bars in good condition. In some cases users of the forced draft furnaces prefer to suppress the slight hissing sound of the steam issuing from the jets. This is accomplished (at a slightly increased cost) by the use of air conduits or pipes fixed to the blower mouths, the conduits or "quietners," as they are called, being carried down to the foot-plates and the air drawn from underneath them. The working of the blowers is thus made a silent operation. In some cases this feature has been utilized for ventilating sewers. The conduits being connected to them and the foul air thus drawn and forced under the grate and used as the air supply to the boiler fires, a constant current of air being thus kept passing through the sewers. I will endeavor shortly to give a description of some of the methods and tools used in the manufacture of the furnaces, and incidentally describe some special phases of English shop practice.



PLANT FOR BURNING REFUSE AT ROCHDALE, ENG.

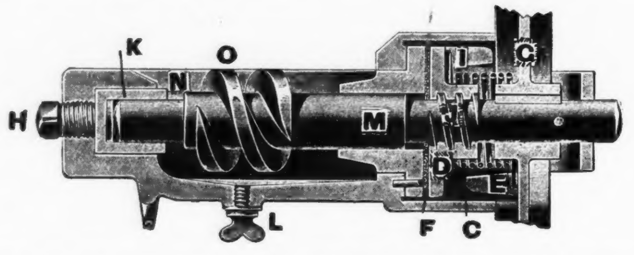
* * *

THE annoying deposit of dust on the ceiling above the belting of a shop can be partially overcome by using a long drop hanger to bring the belts away from the ceiling as far as possible. This of course can only be done where there is sufficient head room to give lathe belts a fair length. Another plan is to hang a brush so as to keep the belt swept clean while running, the dust being deposited in a box below, usually next to a wall for conveniences in fastening.

ITEMS OF MECHANICAL INTEREST.

SAFETY SCREW HOISTING-TACKLE.

The advantages of screw hoisting-tackle are becoming more and more thoroughly appreciated each year; but when higher duty is demanded, and a worm of steeper pitch is used, it is necessary to provide them with a safety stop of some kind to prevent the wheel "running down" the worm. The better the design of wheel and worm, the less the load required to cause this running down. German hoisting apparatus not long on the market has a safety-stop which is here illustrated, and which works well. It



has only one moving part, a friction disc, pressed against a suitable friction surface by a spiral spring. The shaft M, which bears the working worm O, playing in the oil-box N, also bears outside of that oil-box, and on a part of less diameter, a smaller worm J playing in the hub of friction-disc D. This disc has a clutch-tooth I; and the hand-wheel G, which is keyed on the shaft, has also a clutch-tooth E. Rotation of the hand-wheel G thus drives the shaft M and the disc D. The coil-spring C presses the disc D against its friction surface F with a predetermined force. When the hand-wheel G is turned in the direction to hoist the load, there is a slight torsion between the hand-wheel and the friction-disc D, and at the same time a slight endwise motion of the disc towards the hand-wheel, *i. e.*, the friction will be lessened. But when the axis is turned in the direction of lowering the load, whether purposely by the hand-wheel or only by the weight of the load, such turning will only be possible so long as the clutch-claws E and I are in contact. Such turning causes the axis to move lengthwise; and the lengthwise pressure no longer comes on the thrust screw H and bearing K, but between the disc D and the friction-face F. The brake-disc D is of such size and material as to be able to withstand the running down tendency of the load. L is a screw plug to permit emptying the oil-box N.

* * *

LAVATORIES AND BATHS FOR WORKING MINERS.

The German papers give some interesting accounts of the means taken in the Dortmund district to provide miners with the means of changing their wet, dirty clothes on leaving the mines, and washing and dressing before they go home. A series of experiments was made as to the best methods of enabling the miners to perform their ablutions, and dress before going home. At first opposition to the baths was experienced, and then the benefits of the plunge baths were recognized, crowds of miners availed themselves of them, and it was found that a great deal of water would be required. Finally the shower bath was seen to be the bath of the future, and as less water was required a greater number of men could be accommodated; they all had privacy, and the rain drops falling on the bodies quickly exercised a cleansing effect. Now there are provided in the Dortmund district alone 209 lavatories at 167 galleries with 22 shafts, and they afford full washing accommodation to 132,450 men, or about 95.7 per cent. of the entire mining population.

* * *

Don't try to save too much oil—it may ruin a bearing.

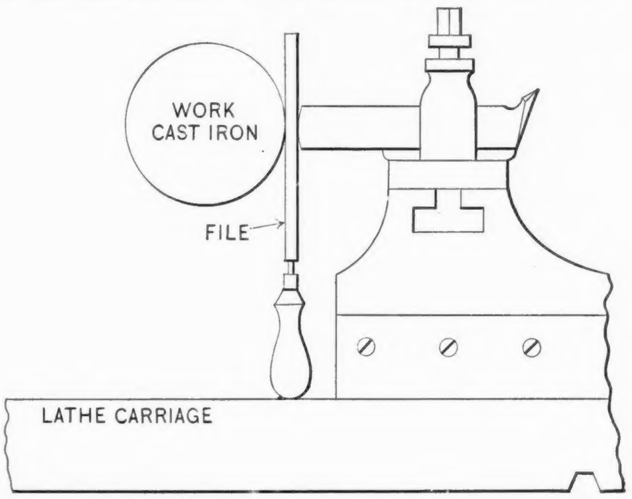
HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

8. W. J. T. asks: What is the principle involved which makes a belt stay on a coned pulley? *A.* It is generally attributed to centrifugal force, or the tendency of any revolving body to get as far away from the center of rotation as possible. With a pulley having its face inclined or "coned" all one way, a belt will work to the high side and when the pulley is high in the center or "crowned" not "coned," both sides of the belt try to work to the highest part and, as they oppose each other with approximately equal force, forcing the belt to stay on the pulley.

9. W. T. writes: Some of the men in our shop use cyanide in hardening dies; they told me they could harden at a lower temperature, thus lessening chances of cracking the steel. After reading the article on steel in your June number, it made me doubt if it did any good. *A.* We submitted this to a steel expert who replies as follows: I do not think there is any necessity for using cyanide, or any other such preparation on the face of a die, provided the steel is of the right kind, and enough has been planed off the surface to entirely remove the scale. This latter is the principal cause of dies not hardening uniformly, and hard enough on the face. Some think that the best steel is on the outside of the bar, and others think you only need to level the face off. Both are mistaken. There should be a good, heavy chip taken from the face of any large die, and a proportionate amount from the face of smaller ones, for the thickness of the scale varies at any time, and is not uniform on any one bar. If this scale is thoroughly removed, the steel will harden at a refining heat without any injury to the die; and if it is heated uniformly, so that corners are not overheated before the piece is ready to cool off, there need be no trouble in getting it hardened deep enough for any work, and in a sound condition.

10. X. A. M. writes: I do not quite understand how the latheman, mentioned in the "Notes by a Roving Contributor," on page



14 of the September issue, used the old file in getting the scale off of cast iron. Can you illustrate this at an early date? *A.* The cut shown with this will probably make this clear to our inquirer.

11. E. T. asks: 1. Give simplest rule for drawing worm gear. *A.* This is very thoroughly discussed by W. L. Cheney on page 53 of this issue. 2. In what issue did "Machine Shop Arithmetic" begin? *A.* September, 1895. 3. In what issue did you give proportions of taps and dies? *A.* February, 1896, page 184. 4. What is the proper speed and feed for milling machines? *A.* Depends much on conditions and can best be determined by experiment on the particular work you have. A fair average probably is: steel, 36; wrought iron, 48; cast iron, 60; brass, 120 feet per minute of cutters. There are instances of as high as 200 feet per minute on cast iron, but these are exceptional cases. Feeds also vary in like manner. Feed all the cutters and work will stand. Other questions will be answered later.

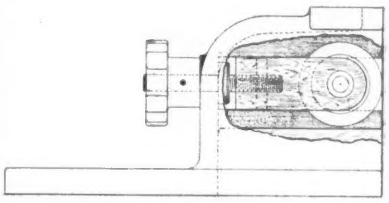
* * *

An exceedingly useful little book, vest pocket size, called "Facts and Suggestions about Files," is published by the Arcade File Works, 97 Chambers Street, New York, which every one should have who uses files on his work, or who is at all interested in the subject. In addition to many practical points on the use of files, the book contains some 60 pages of section-lined paper especially adapted for mechanical memoranda. It will be sent to any one who writes to the above address and mentions Machinery.

* * *

NEW EMERY WHEEL DRESSER.

We show with this a cut of a new emery-wheel dresser and rest for use on wet emery tool grinders. The great disadvantage of emery wheels in water tool grinders heretofore, has been their liability to get out of true and the difficulty in turning them up. The device overcomes this difficulty, and the operator has only to turn the screw and the wheel is trued while he is grinding. The time to true an emery wheel is when it shows the first indications of being out of round, but this is rarely done, and the emery wheel is soon so badly out of true, that a diamond is required to turn it up, which is sometimes a very expensive operation.



With this device, however, it is easier to keep the wheel true than to let it get out of round, so that it is always in perfect condition. It is also possible for the manufacturer to make a harder wheel than he would otherwise dare to do for this purpose, as this dresser will remove any glaze and keep the surface clean and in good cutting condition. The dresser is made either of tool steel threaded about eight threads to the inch, or with chilled iron cutters, which can be replaced at a slight cost.

These rests have been put in places where they had abandoned the use of emery wheels, on account of the unsatisfactory working of the wheel, and it has made the emery-wheel tool grinder a success where it had been discarded as a failure. They are made to fit any make of tool grinder. They are manufactured by the Hampden Corundum Wheel Co., Brightwood, Mass.

* * *

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

THE ORIGINAL CORLISS PUMPING ENGINE.

The article and illustrations in your September issue, showing this old, and in some ways wonderful, pumping engine, brought to mind the test made before its acceptance. Its great range of duty was remarkable, being capable of running from one turn in two minutes up to thirty turns per minute. The test was made when the engine was doing its regular work (pump all the water that was being used) making one turn in seventy seconds and holding the water pressure at about 55 pounds. At a given signal they opened 20 fire hydrants at once, and the engine immediately speeded up automatically to thirty turns per minute without lowering the pressure in the mains over 5 pounds and held it for at least 30 minutes. The only reason it could not hold it indefinitely was that the boiler capacity was insufficient to supply it with steam. When first put up the cut-off was operated by the governor. The air pump was run by a single acting Corliss engine, independently of the main engine. *Ex-Providence.*

Princeton, N. J.

THE STRENGTH OF HYDRAULIC CYLINDERS.

The widely varying results in the discussion of the above subject suggest that for cylinders of this size and for such a heavy pressure, a considerable reduction in the weight might safely be made by employing the well-known Rodman process for casting ordnance.

By this process, the casting is cooled from the *inside* by circulating water through the core. The metal next to the core is cooled first, then the metal outside of that cools and contracts upon that already solidified.

What takes place and the conditions existing when the whole has cooled, may be more apparent by considering the body of the cylinder to be made up of many co-axial layers or rings which are contracted successively upon those inside of them. This

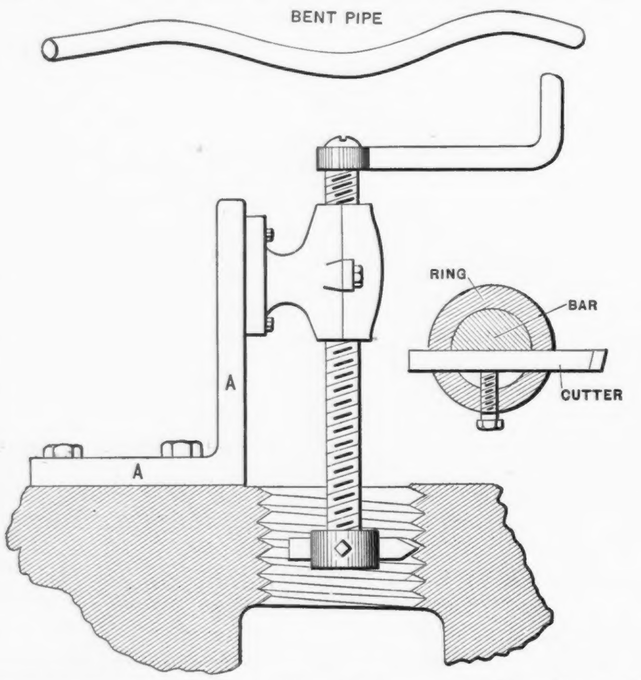
leaves most of the metal in a state of initial stress; that near the bore being in compression and that near the outside in tension.

It will be seen that, in a casting made in this manner, any pressure from within must first be transmitted to, and overcome considerable of the resistance of the metal near the outside before that near the bore can be subjected to *any* tensile or bursting strain. In this way the outer parts are compelled to bear their share of the strain, whereas, in a thick casting made in the ordinary way, it is quite conceivable that the metal near the bore might be strained to its ultimate limit, while that near the outside is exerting very little resistance. W. T. HARDER.

Carlisle, Pa.

STRAIGHTENING WIRE.—TAPPING VALVES.

A new hand in our shop brought with him a dodge for straightening wire. Kink a piece of ⅜-inch gas pipe about 18 inches long, thus: Hold one end in chuck of hollow spindle lathe, speed



away up, grease the wire and pull it through; this worked well on any wire up to $\frac{3}{16}$-inch.

We had some holes about 4½ inches in diameter to tap in a pump casting; we made taps, but it took so much power and they made such a poor job that we devised the following scheme: An angle plate, A, bolted to face of casting, with a spindle threaded (the same pitch as we wished in the hole), an old box babbitted for thread of spindle to travel in, and bolted to angle plate. The cutter, of ½-inch round self-hardening steel, was held in place by aid of set screw and collar and was loosened after each cut, so it did not become dull backing out and was ready to be set out a little farther for next cut.

Toronto, Canada. W. J. THOMPSON.

GEARS FOR SCREW CUTTING.

I have in mind a lathe that could be used for cutting a great variety of pitches for screw threads, many more than were shown on the index plate. This lathe has a lead screw of six threads per inch and change gears from 24 teeth increasing by 4 up to 72; the driving pinion was on a stud which made the same number of revolutions as the lathe spindle. To cut the threads shown on the index plate this pinion was not taken off. The change gears being placed on the lead screw only. There was a compound for this lathe, which consists of two gears keyed together and which turned upon a stationary stud. One of these gears had twice as many teeth as the other. According to the index plate, threads could be cut from 6 to 18 per inch, single geared, and by putting the compound in mesh the same gears would make (by even numbers) threads from 20 to 36 per inch. It will be seen that the compound doubles the number of threads which can be cut by using the same change gears. But the range of the lathe for cutting screws was greatly increased by making a bush to fit the change gears, and boring holes to fit the stud used for compounding. The bush had a keyway cut on it to fit the spline of change gears, so they could be keyed together.

Suppose, for example, it was required to cut 40 threads per inch. Then as the lead screw is 6 per inch, the ratio of driving gears to driven would be as 6 is to 40. Then resolve the numbers $\frac{6}{40}$ into two factors each, as $\frac{6}{40} = \frac{2 \times 3}{4 \times 10}$. In this case the change gears of lathe would not furnish the gear required; as the smallest has 24 teeth and the largest 72, no greater ratio than 3 to 1 could be made. The order in which the factors are, would call for one pair of drivers and driven, in a ratio of 1 to 2 and the other from 3 to 10. So we shall try again.

Now multiplying both terms of the $\frac{6}{40}$ by 2 we get $\frac{12}{80}$, which is in the same ratio. And factoring we get $\frac{3 \times 4}{8 \times 10}$. Multiplying $\frac{3}{8}$ by any number which will raise the figures so they can be found among the change gears, as $\frac{8 \times 3}{8 \times 8} = \frac{24}{64}$ we get one pair of gears and $\frac{6 \times 4}{6 \times 10} = \frac{24}{60}$ gives the other pair. The gears should be placed on lathe as follows:

24, on stud.
60-24, on stud for compounding.
64, on lead screw of lathe.

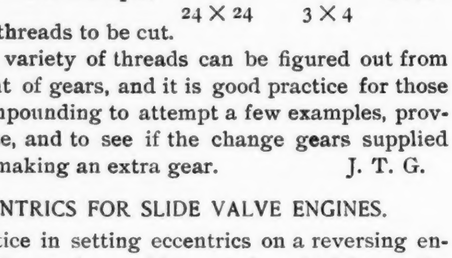
The upper numbers (or gears) in mesh with the ones beneath them. In practice, there would probably be an intermediate wheel or gear between the stud used for compound and lead screw, but this would not affect the ratio. In connection with compounding gears, it is well to remember that the product of the number of teeth in the driving gears, multiplied by the threads to be cut, equals the product of the driven gears times the threads per inch of lead screw. To prove that our calculation is correct, we could multiply the product of the driven gears by the threads per inch of lead screw and divide by the drivers, the result would give the threads to be cut. It will be shorter to multiply and divide by cancellation. For example, $\frac{64 \times 60 \times 6}{24 \times 24} = \frac{8 \times 60}{3 \times 4} = 2 \times 20 = 40$, the number of threads to be cut.

As stated, a great variety of threads can be figured out from such an arrangement of gears, and it is good practice for those not familiar with compounding to attempt a few examples, proving them in each case, and to see if the change gears supplied can be used without making an extra gear. J. T. G.

SETTING ECCENTRICS FOR SLIDE VALVE ENGINES.

The ordinary practice in setting eccentrics on a reversing engine is to assemble the engine and by a series of trials set the eccentrics for ahead and backing gear, then take down the rods, etc., key the eccentrics and put everything in place again.

Correct results can be obtained in this way, but on an engine of any considerable size it requires a large gang of men and consumes considerable time to set the eccentrics, disconnect, key the eccentrics and connect up again.



The eccentrics can better be set and keyed in their correct position on the shaft before it is put into the engine-bed, and thus save time and money.

In designing a valve for an engine the desired steam lead, opening, cut-off, compression and exhaust lead are decided upon and he valve proportioned accordingly for a suitable throw of eccentric. Knowing the above, it is a very simple matter to set the eccentrics on the crank-shaft, whether in or out of the bed. To do this place the crank on either center, though usually it is more convenient to use the top center, then slip the eccentric along on the shaft to its correct position from the center line of the engine. Now, if the eccentrics handle the valve direct, without the intervention of a rocker-shaft, the eccentric will be placed on the lower quarter in the direction the engine is to turn.

To find the angular position of the eccentric, first determine from the known data of the valve the distance the valve opens after the crank passes the center, then set the eccentric on the point of extreme throw; now set a surface gauge or squares this distance back of the outside of the eccentric, roll the eccentric around the shaft till the outside surface of the eccentric reaches the gauge and the eccentric is in its correct position.

Example: Suppose we have a valve that is to be set with $\frac{1}{16}$ lead on top and $\frac{15}{16}$-inch opening to steam on top. From this we know that the valve must travel, after the crank passes the center, the opening $\frac{15}{16}$-inch, less the lead $\frac{1}{16}$, or $\frac{7}{8}$-inch, now set the crank, as per sketch, on a planer bed or other platten with the eccentric at the lowest point, set the gauge $\frac{7}{8}$-inch above the outside of the eccentric and roll the eccentric to this point. The eccentric is in its correct position and the keyways can be marked and keys fitted. The other eccentric should be set in the same way on the other quarter.

Wm. L. Tobey.

* * *

MANUFACTURERS' NOTES.

The Crane Elevator Co., Chicago, Ill., send us a description of, and the results obtained from the large freight elevator plant installed in the Samuel Cupples Real Estate Co.'s Warehouse, St. Louis, Mo., which is especially interesting on account of its radical features. The plant consists of 52 elevators, 49 of which were in use during the test. The guarantee was that with the whole plant running, a round trip of 170 feet should be made with each elevator every 9 minutes for 12 hours, carrying 4 000 pounds load, should not cost more than 8 1-2 cents per day for fuel. The test, with 49 elevators, performed the service mentioned at a cost of 4.16 per day for fuel, a remarkable showing. They also occupy little room, which is a big item in large buildings.

The George Burnham Co., 15 Hermon Street, Worcester, Mass., are now making a 4 spindle multiple in addition to the other made by them. One change from the others is that the spindles are but 8 inches apart instead of 10, which is a convenience many times. The table is 12 by 38 inches, giving plenty of room for work. The base is 24 inches in diameter, insuring stability while at work. The spindle pulleys are 5, 6, 7 and 8 inches in diameter respectively.

* * *

FRESH FROM THE PRESS.

The Chicago Main Drainage Channel. Chas. S. Hill. Engineering News Publishing Co., New York. 126 pages, 8¼ by 11 inches. Price, $1.50.

This is one of the most complete books on such a subject that we have ever seen, and though portions of it have appeared in the *Engineering News* from time to time, it loses none of its interest on that account. It contains a complete description of the methods and machinery employed in the work, and as there were quite a number of contractors, each using a different method, this is a very valuable feature. It is fully illustrated with diagrams and photographic reproductions. The appendix deals with the questions of popular interest concerning this great work, which is of almost world-wide interest.

A Course in Mechanical Drawing. Louis Rouillion, B. S. The Prang Educational Co., New York. 86 pages, 6 x 7½ inches. Price, $1.25.

This is a revision of the course which has appeared in Machinery during the past year, and is both neat and convenient as a text book. A special feature is in having the illustrations face the text having reference to them, which will be appreciated by every student, as it avoids the continual turning of leaves to follow the description letter by letter. If we can judge by the frequent calls for the issues of Machinery containing these articles, the book should have a wide sale, as it is sure to be favorably received.

The Journal of the American Foundrymen's Association. Vol. I., No. 1. Detroit, Mich 172 pages, 6 x 9 inches. Price, 50 cents per copy; $5.00 per year.

This is the July issue, but has been delayed in printing; the August and September numbers are to follow closely, so as to catch up as soon as possible. It contains the proceedings of the First National Convention of Foundrymen, which were extremely interesting, a list of members and other matter. It should be a valuable journal for foundrymen generally and ought to be kept for reference by every one interested in modern foundry matters.

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ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9X12, 6X9 AND 3½X6 INCHES. THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

The Davis & Egan Machine Tool Co., of Cincinnati, Ohio, have just issued a handsome catalog illustrating and describing their line of Bicycle Machinery. It is of standard size, 9x12.

Westinghouse Machine Co. Pittsburgh, Pa. Gas Engines.

This is more of an announcement than a catalog, which wastes no words in telling the good points of their products. This engine will attract wide attention, and the catalog will be found of value to any one interested in comparatively small power motors.

Waterbury Farrel Foundry & Machine Co. Waterbury, Conn. Index to 1897 catalog, and circulars.

It is quite a novel idea to send a catalog index in advance to enable any one to see just what it will contain. The small catalog contains miniature illustrations of 180 machines, full details of which will be forwarded on request.

P. Blaisdell & Co., Worcester, Mass. Catalog of Lathes and Drills. 28 pages, 6x9½ inches.

This shows the well-known Blaisdell Lathe and some of its details, including the different styles of carriages and the taper attachment. They also make hand lathes and turrets.

The Lidgerwood Mfg. Co., 96 Liberty street, New York, have issued a second edition of their illustrated sketch book on contractors' methods employed on the great Chicago drainage canal. This is a nicely illustrated book of 72 pages, which will be sent on application.